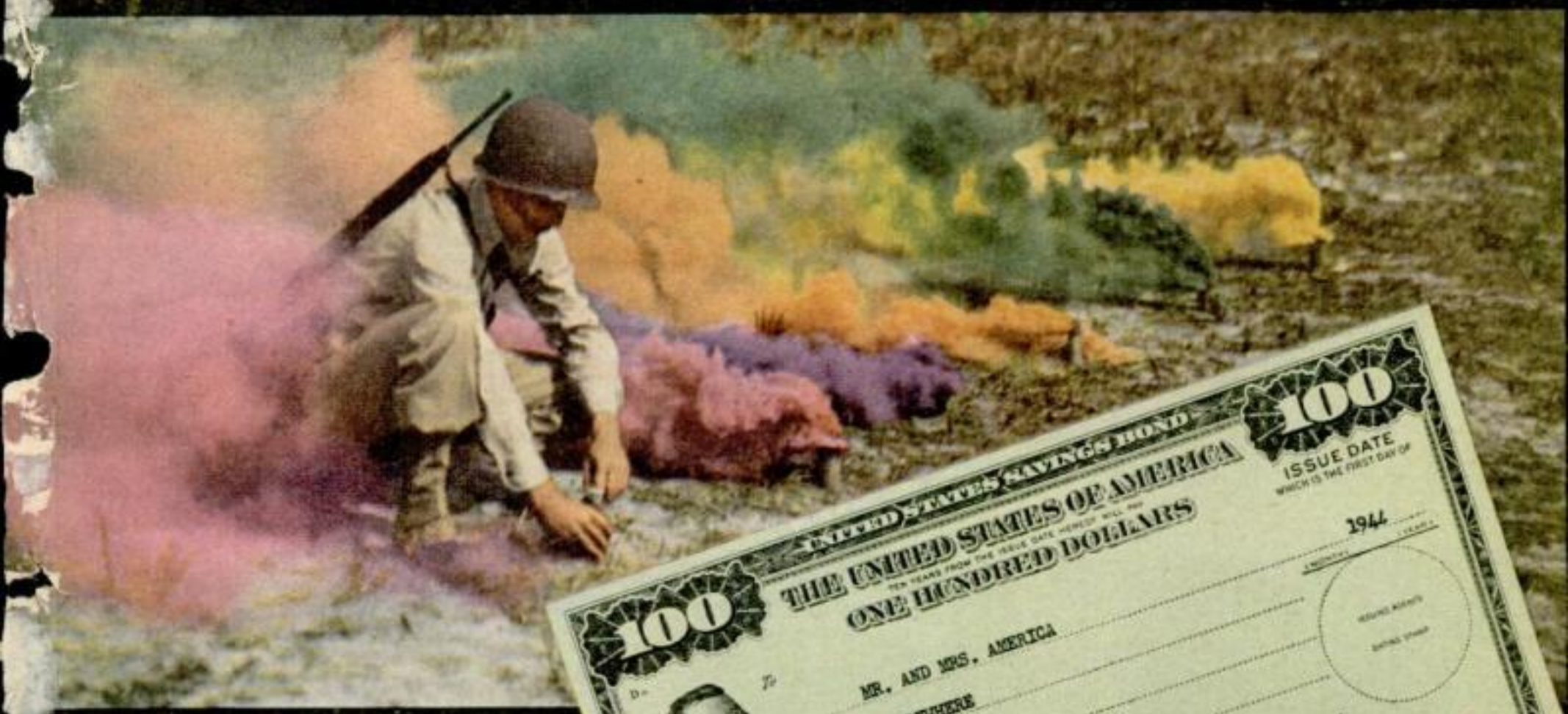


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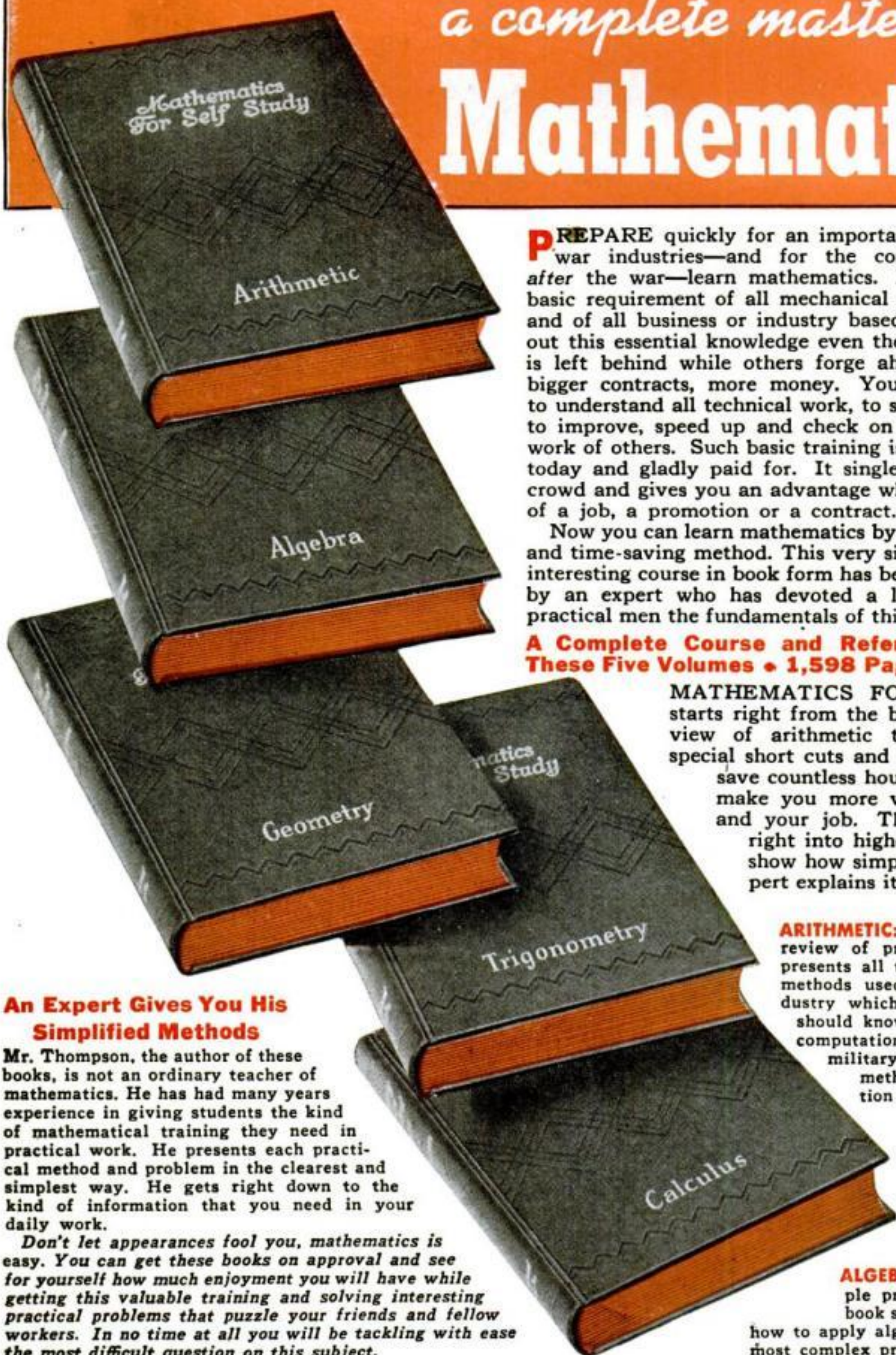
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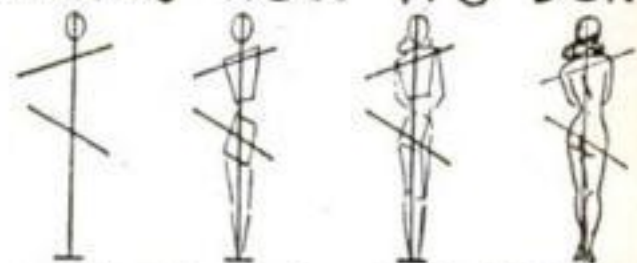
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Kodachromes on cover: Photograph of smoke bombs is by Hans Groenhoff, and that of Chinese ceremonial vessel by William W. Morris. The one of a railway gun is from the Army Signal Corps.

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LETTING THE CALENDAR CATCH UP

TO BRING the date when POPULAR SCIENCE MONTHLY goes on sale closer to the date on the cover of the magazine, the August 1944 issue will be published on July 19 and the September issue on August 30. Thereafter, each issue will be published on or about the first of the month that is shown on the cover.

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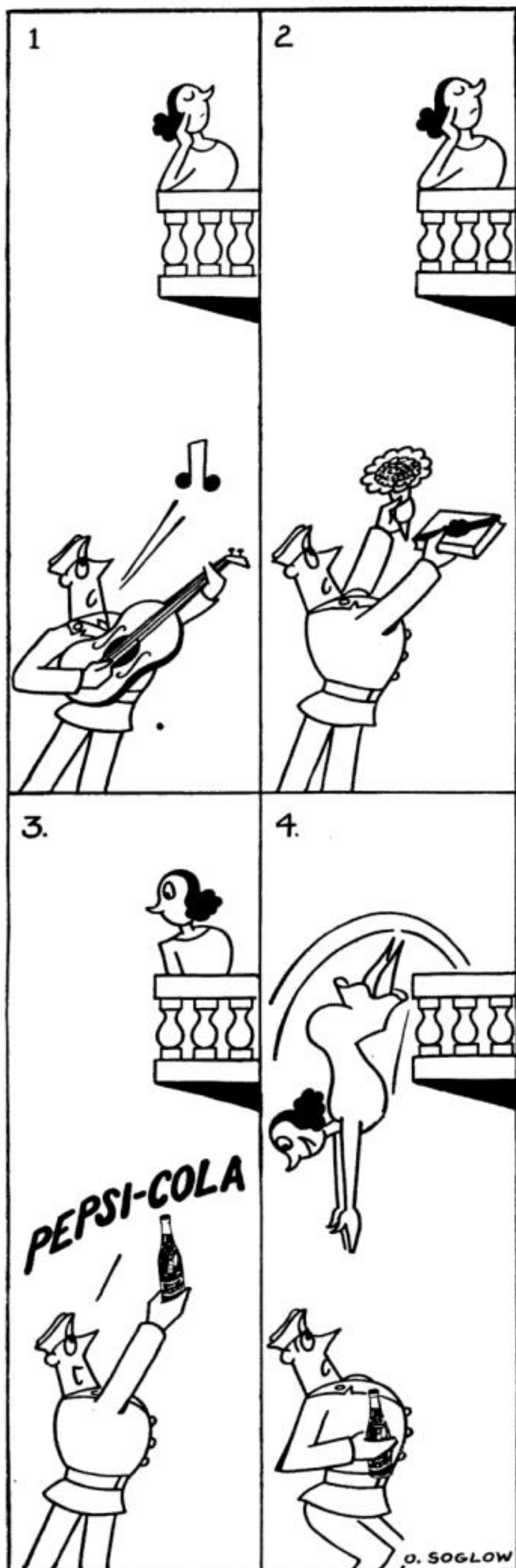
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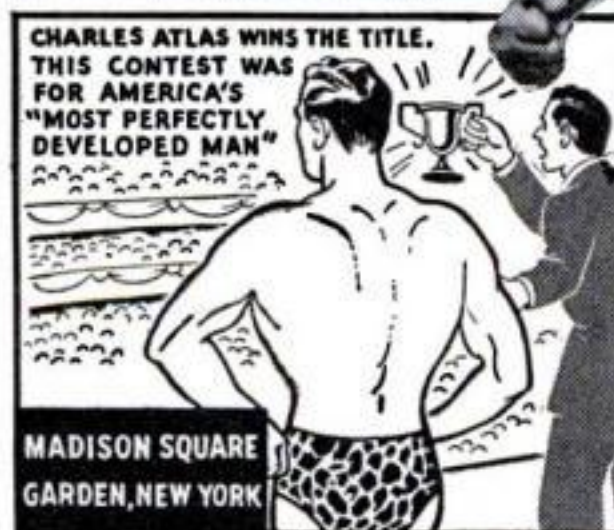
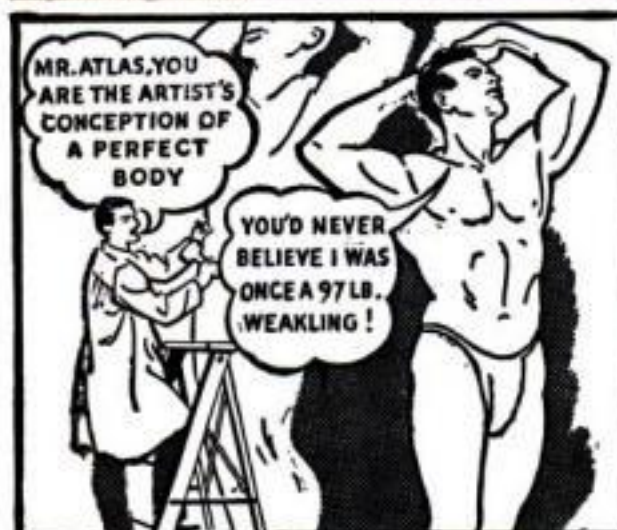
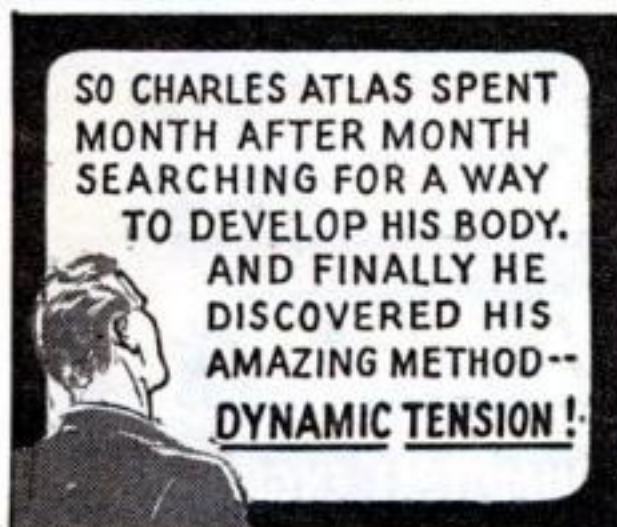
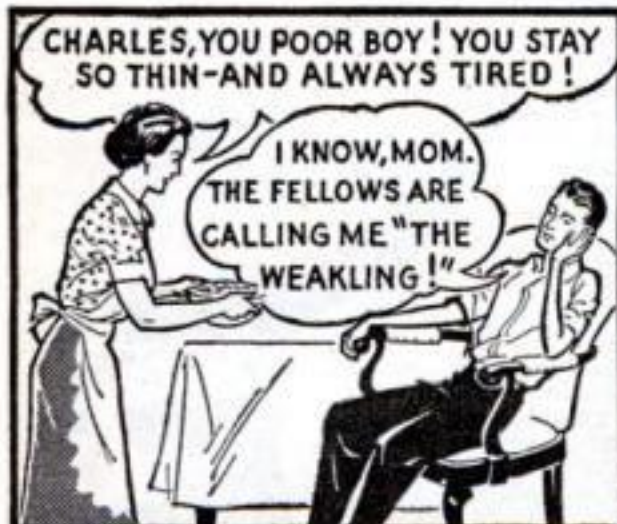
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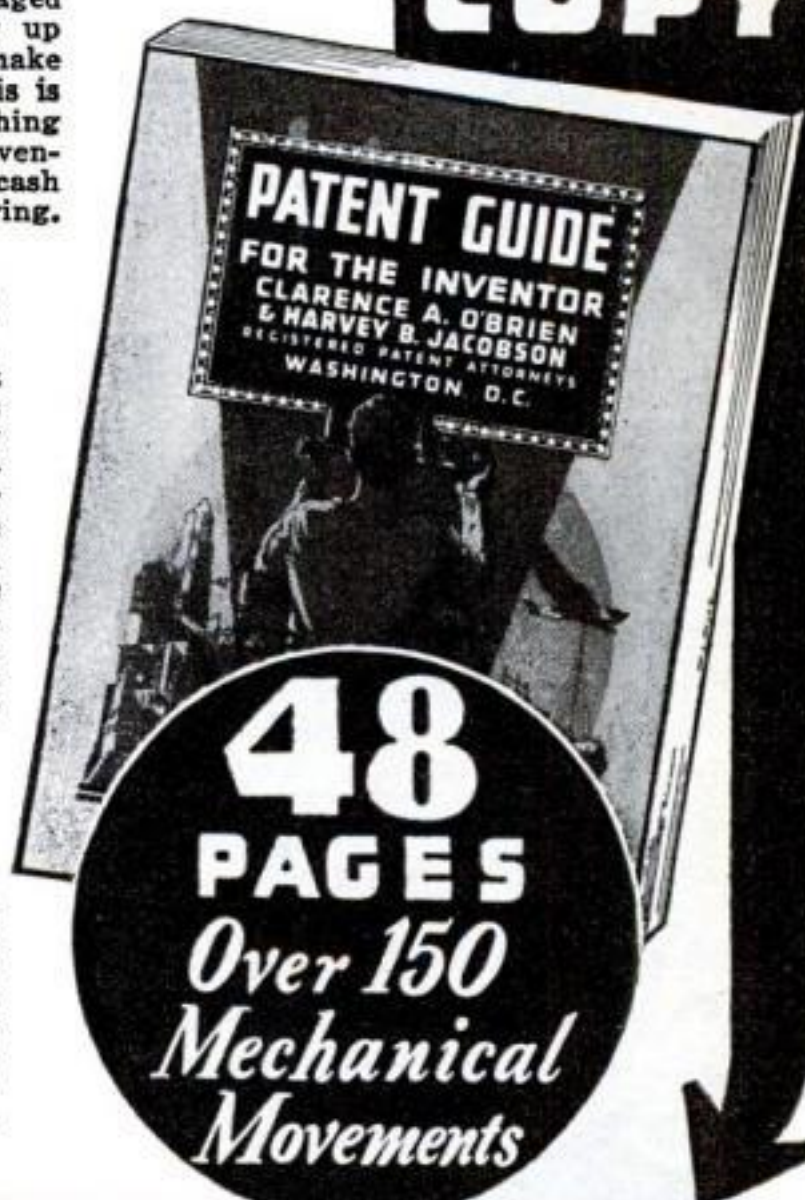
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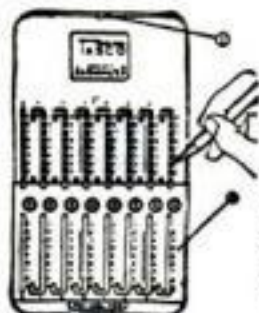
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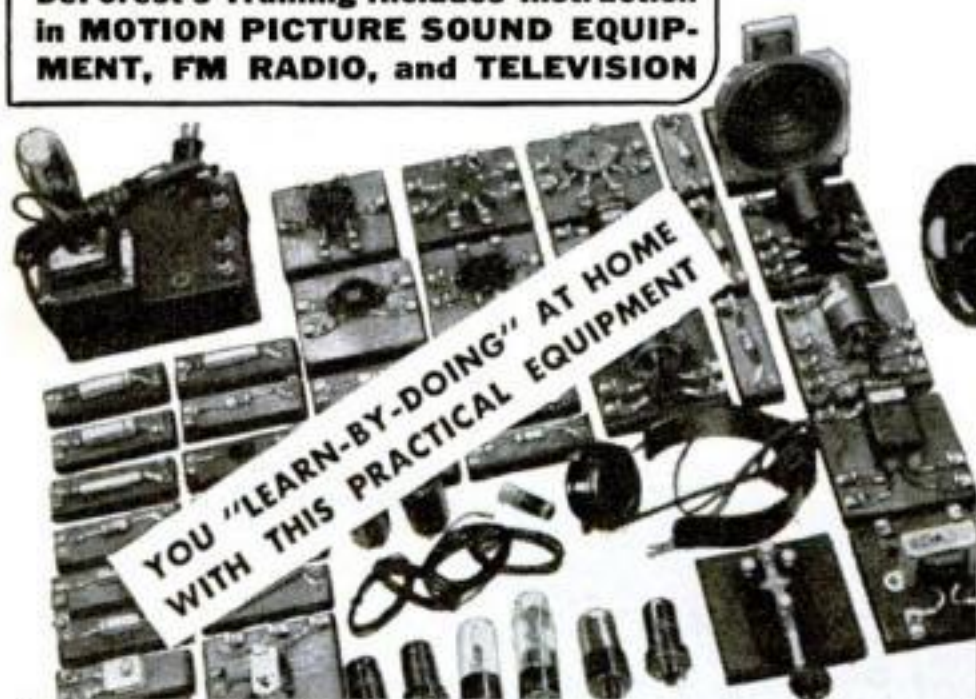
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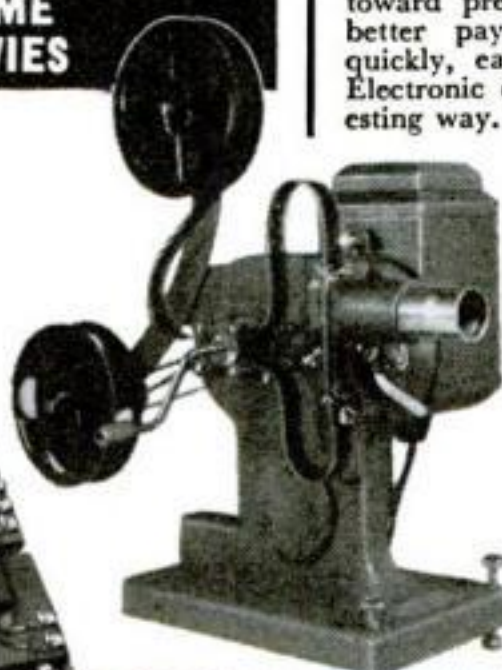
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However Humble It May Be, There's No Place Like an LST

SOME time ago, P.S.M. ran a contest on how to use jeeps after the war, and I must say there were some good ideas. Now, me, I'm gonna get me one of these here LST's I hear so much about, and some moonlight night, on a neap tide, run her up on a beach where the breaking waves don't dash too high, make her fast to the shore, and let her settle. Anywhere from the Caribbean to New Brunswick will do. I was weaned on coconut pulp and orange juice, and I like quahog chowder too, but you can leave out the tomato. And then I'll LIVE. At low tide I'll dig clams; at high tide I'll catch flounders. I'll drive my car into the bowels of the LST; lift my drawbridge or drop the portcullis,



and there I am safe. When the sun shines, I'll sit under my awning and read P.S.M. When it rains, I'll tinker with the machinery 'tween decks. The gentle breezes will fan me; the sirens will sing to me; old Father Neptune and I will be chums. What would my fellow readers do with an LST when they

become available?—P. E. C., Wrentham, Mass.

Face-Lifting Changes Jeep into Limousine

I WOULD like to submit a picture of a jeep that I enclosed while I was stationed at Patterson Field, Ohio, in the 1st Radio Squadron. The doors are made of radio plywood with Plexiglas windows. The doors can be removed by pulling out two pins on each. Canvas sides are fitted with .1500-gauge Plexiglas. The car has a heater and air windshield wipers. The top is reinforced so that the jeep can turn over without injury to the occupants. It can be converted back



This Army sergeant turned out a convertible luxury car by enclosing the jeep and installing a heater to an overseas command car in five minutes.—Sgt. P. T., O'Fallon, Ill.

When the Censor Jims Works on Stamps from Abroad

LATELY in the course of collecting stamps, I have encountered a tape more troublesome than the famous red tape. This certain tape is used by censors to seal up opened letters. It often covers part of the stamps, and my problem is how to remove this tape without damaging them. I have tried soaking and numerous other methods to no avail. I would appreciate any helpful suggestions from P. S. M. readers. Keep those swell aviation articles coming.—J. R. C., LaGrange, Ill.

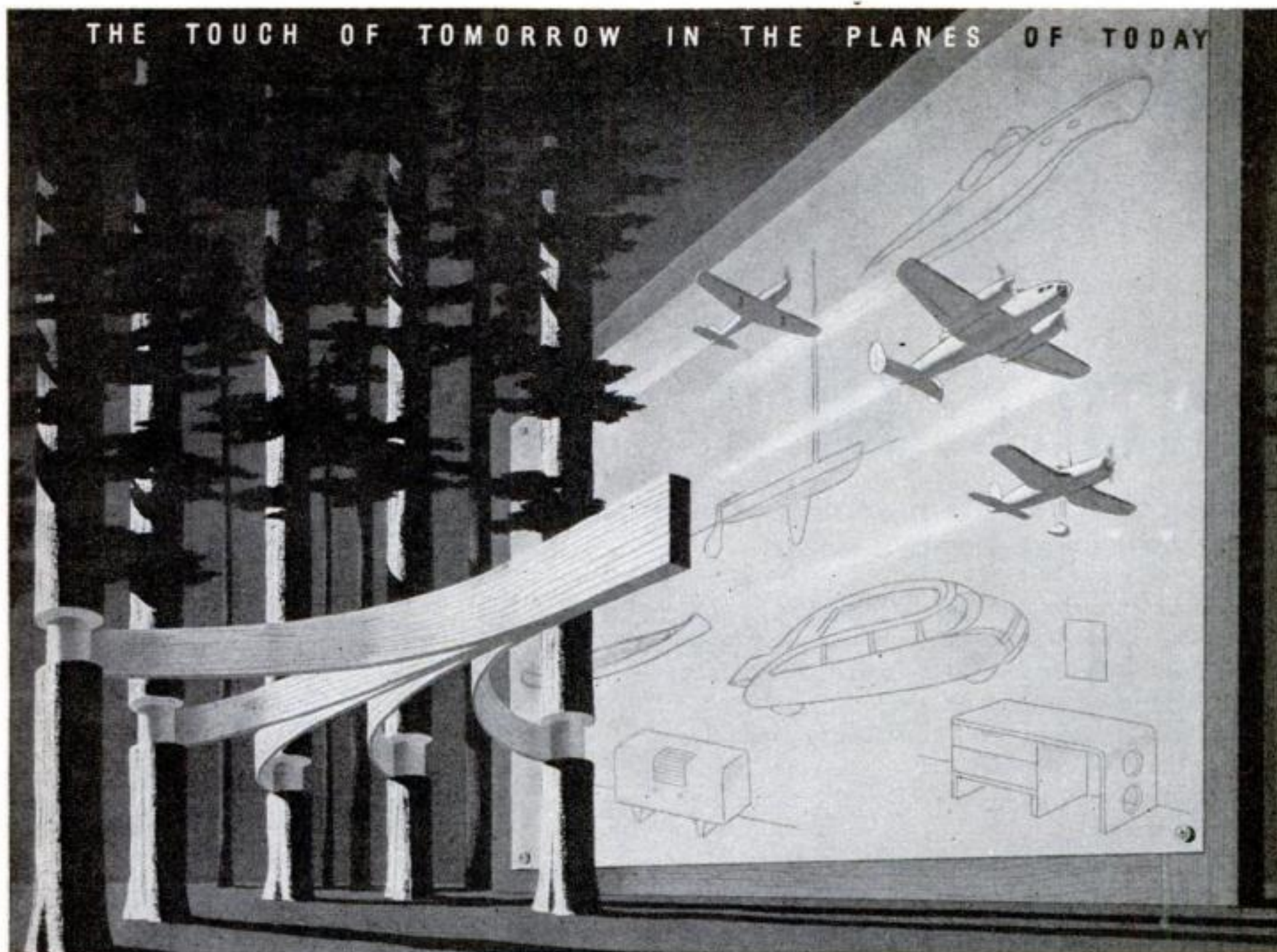
Inquiry made to the Scott Stamp and Coin Co., New York City, elicited the information that benzine is usually an effective means of removing the transparent sealing known as Scotch Tape. Perhaps P. S. M. readers will have further ideas for the solution of this philatelic problem.—Ed.

British Reader Is Amazed at P. S. M. War Coverage

You have a great magazine as regards articles and illustrations. We have a rigid censorship in this country, and your magazine is a revelation. How you pass the censor is amazing, but it certainly keeps me up to date.—T. B., Cardiff, Great Britain.

Every page of P. S. M., of whatever nature, is submitted in advance to the Office of Censorship; and all articles on the U. S. armed forces or their equipment pass the scrutiny of proper authority in advance of their publication.—Ed.

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Readers Say:

P. S. M. Zoo Begins to Assume Noah's-Ark Proportions

E. F. A.'s letter about a P.S.M. zoo struck me as a rather good idea. Two mechanical things he missed are the crowbar and spider gear. In answer to the query as to the source of the name "monkey wrench," I seem to remember reading somewhere that a certain man named Monkey devised a new type of wrench that eventually became known by the name of its inventor.—D. L. C., Williamsport, Pa.

THE MONKEY wrench is the most peculiar of all the animal tool kingdom, and if E. F. A. ever used one to any extent he would not be asking how it got its name, for you have to monkey with it to get it adjusted, monkey with it to keep it so, and monkey with it to do whatever monkey business you



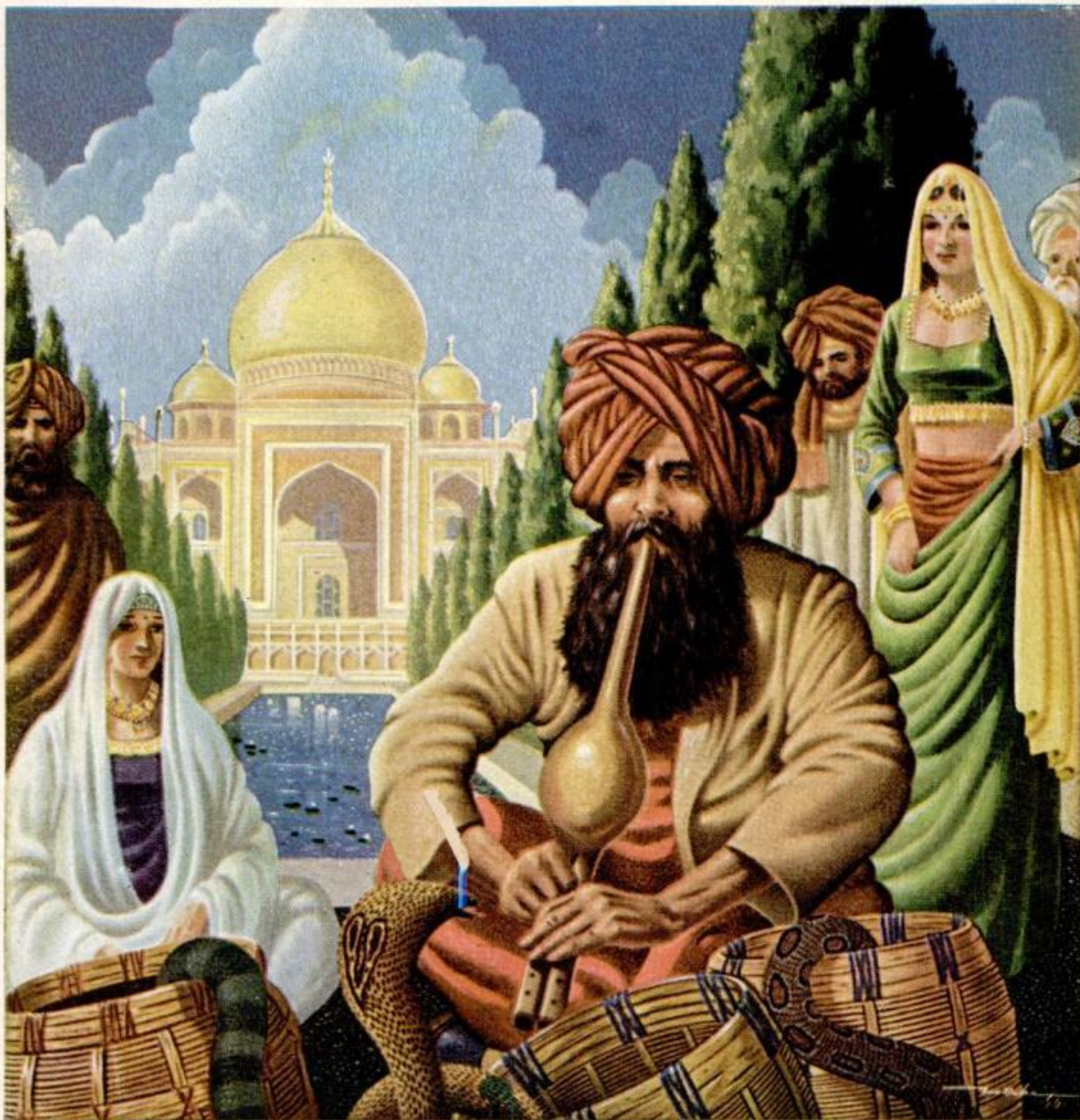
want to do. When using it, you should always have on hand bandages, a doctor's telephone number, and an insurance policy. And last, it makes a monkey out of you. Here are a few other eligibles for the P.S.M. Zoo: alligator wrench, crowbar, beetle, duck-bill pliers, cat's-paw, sheepshank, bucksaw, bulldozer, turtleback,

and clam.—C. A. V., Portlock, Va.

SINCE E. F. A.'s sleepless night, when he lay awake planning a P.S.M. zoo, I have developed incurable insomnia. I arise in the morning—deep circles under my eyes—having spent long hours thinking up "eligible specimens." Dolphins, dragons, snails, snappers, lugs, and slugs, to say nothing of dogs, worm gears, and butterfly valves, parade in my fevered mind. In their train is a host of pigs, swallows, and skimmers. Can't this thing be stopped?—P. L., New York, N. Y.

Bathtub Sitter Cogitates on Scientific Phenomenon

PERHAPS some reader can explain this phenomenon. If a person sits in a bathtub while the water is going out, the bathtub will take less time to be emptied than if he were not in there at all.—S. H., New York, N. Y.



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on your scientific education. The magazine comes in handy, too, while you are waiting in that old chow line.
—Pfc. J. F. U., Tampa, Fla.



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ward to a military career, plus POPULAR SCIENCE every month.—Ed.

Time to Investigate When You Can't Douse the Glim

I WAS very much interested in the article "Lamps of Tomorrow" in the May P.S.M. It so happens that such a phenomenon as lights by radio caused me to make a couple of service calls. I had previously installed three fluorescent fixtures in a doctor's office. When he could not turn off the lights, I was called. When I arrived, the lights worked normally. Several days later I was called again, and this time I could not turn the lights off. I then removed one of the tubes, and it continued to glow as long as I kept it within two feet of the fixture. When I questioned the doctor, I found out that he was giving a patient a diathermy treatment. I was flabbergasted, but curious to find out more about this sort of electrical-energy transmission. But leave it to P.S.M. Let's have more articles about fluorescent lighting, especially maintenance short cuts.—A. J. H., Carrollton, Ill.

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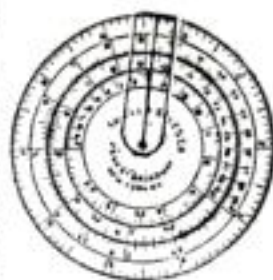
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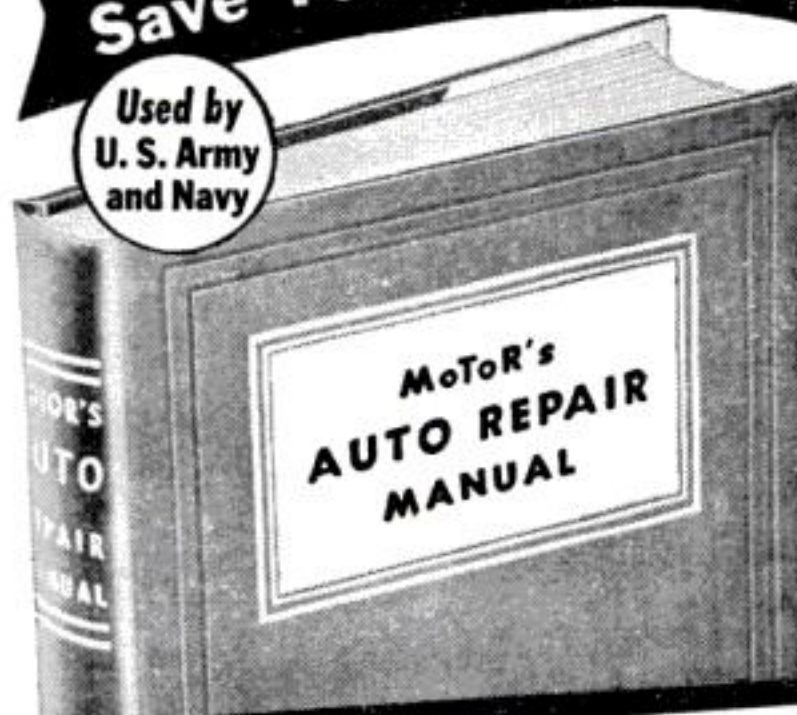
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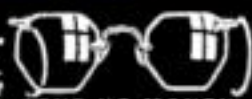
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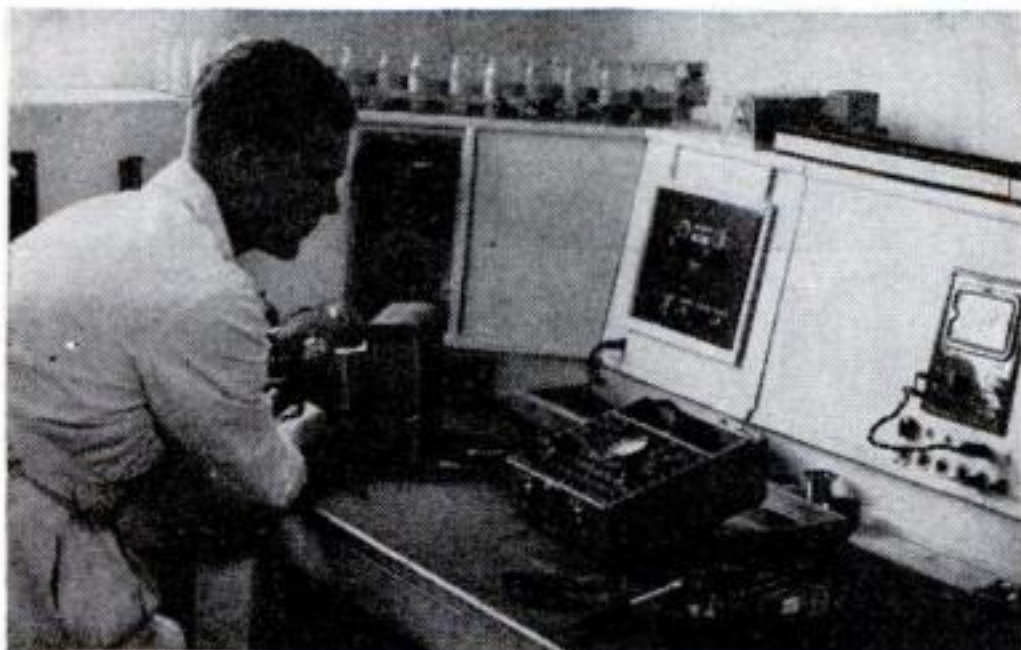
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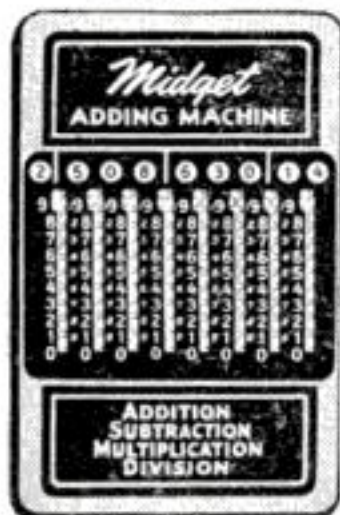
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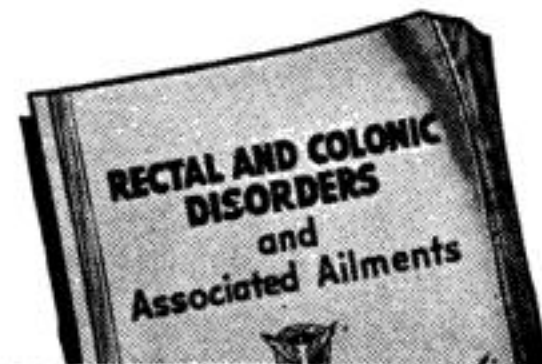
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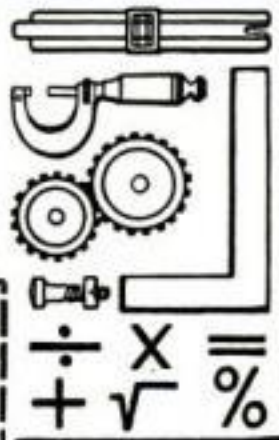
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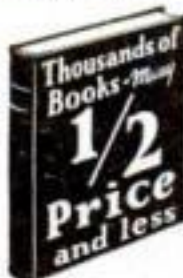
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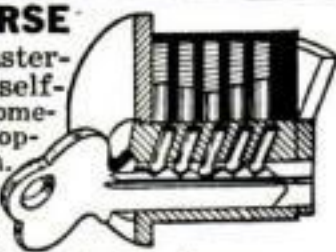
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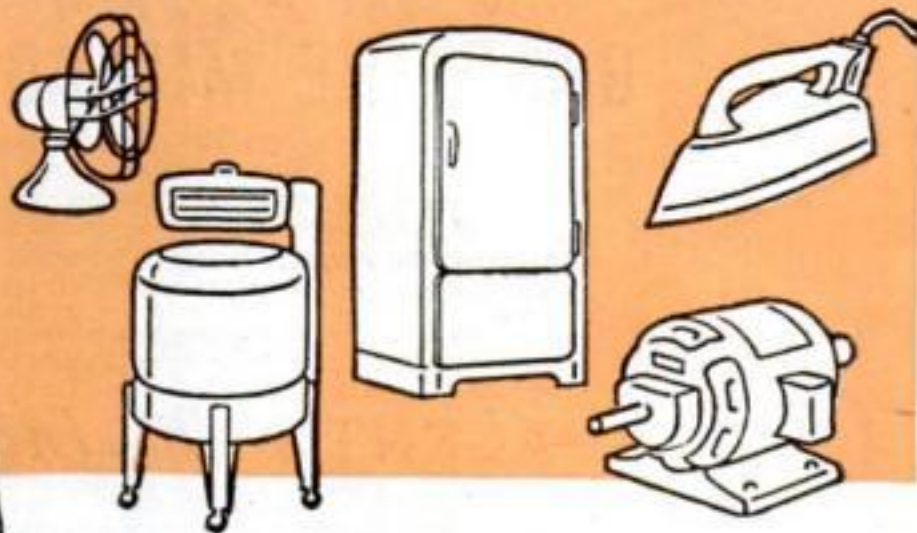
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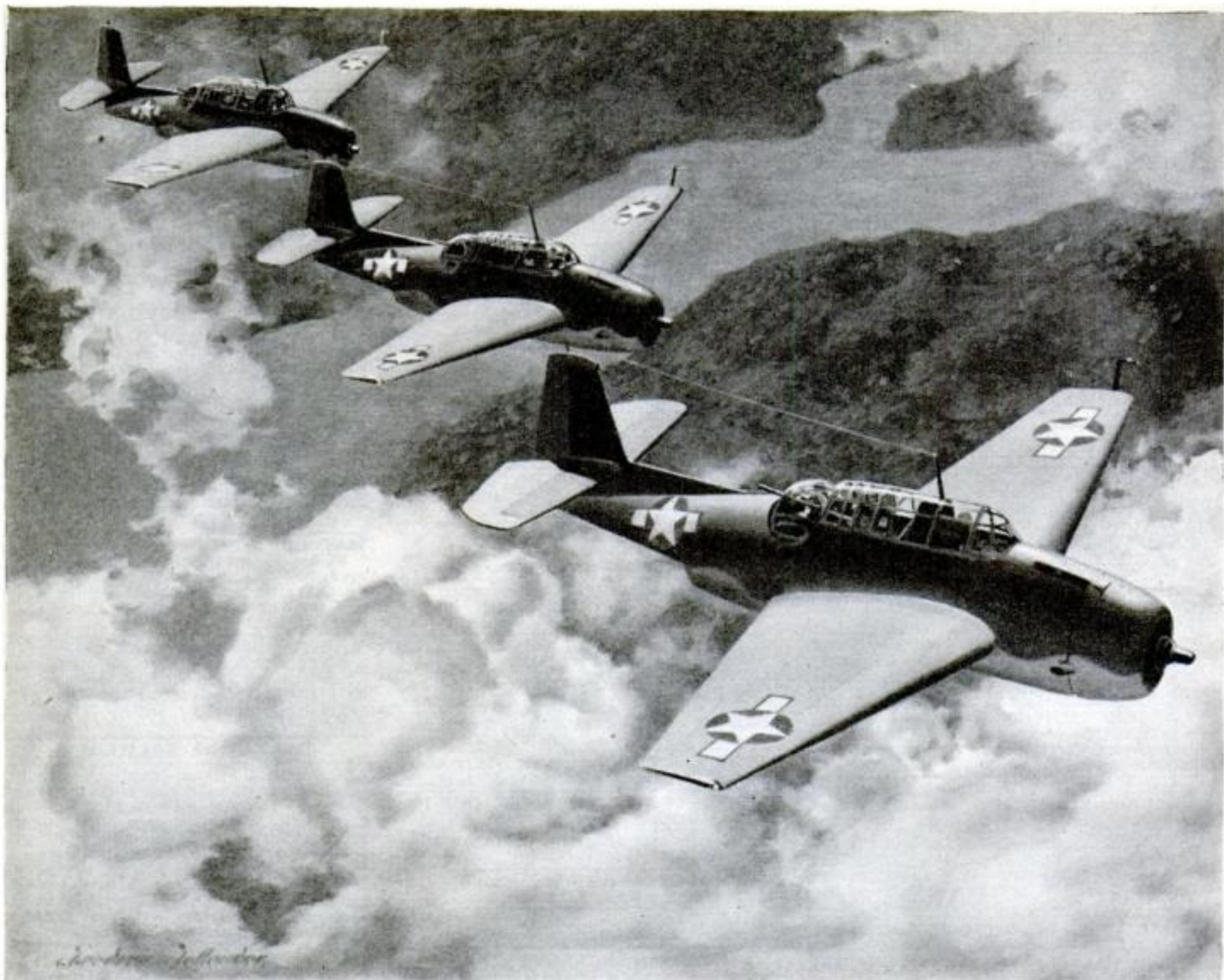
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For relief from this exhausting strain, the pilot turns the controls over to "Elmer"—the Automatic Pilot. It obeys orders without question, flies the plane with uncanny accuracy on whatever level course the human pilot determines. It is a vital strategic device helping to keep flying personnel at peak efficiency—a unit of exceedingly delicate balance, demanding the finest precision workmanship in construction.

We are proud that we have been called upon, because of our specialized experience, to build the hydraulic parts for this automatic pilot. Their mass production is an achievement in precision manufacture which has won the recognition of the Navy air forces.

*Pilot's nickname

LET'S ALL BACK THE ATTACK—BUY MORE WAR BONDS

Besides hydraulic parts for the Automatic Pilot, this company also manufactures the Hycon "Stratopower" pump—now standard equipment on the Lockheed P-38 and reserved exclusively for our fighting planes until victory is won.

Today there are available for immediate delivery other Hycon Pumps and Valves in the 3000-pound range for commercial applications to control or actuate machine tools, giant presses, dump truck lifts, materials-handling mechanisms and remote control circuits. They will operate brakes, clutches and steering devices of heavy vehicles; test high-pressure apparatus; and solve a wide variety of other hydraulic problems. Write for full information.



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THE "RAFWAFFE" FLIES FOR US



The only "circus" of its kind in the world, the "Rafwaffe," flown by British pilots and featuring such Nazi planes as the Focke-Wulf 190, ME-110, JU-88, and Henschel 129, plays exclusively to audiences composed of American and British pilots

Captured Nazi planes reveal their secrets to Allied pilots in strange circus staged by the RAF to show how enemy's latest aircraft behave.

By HICKMAN POWELL

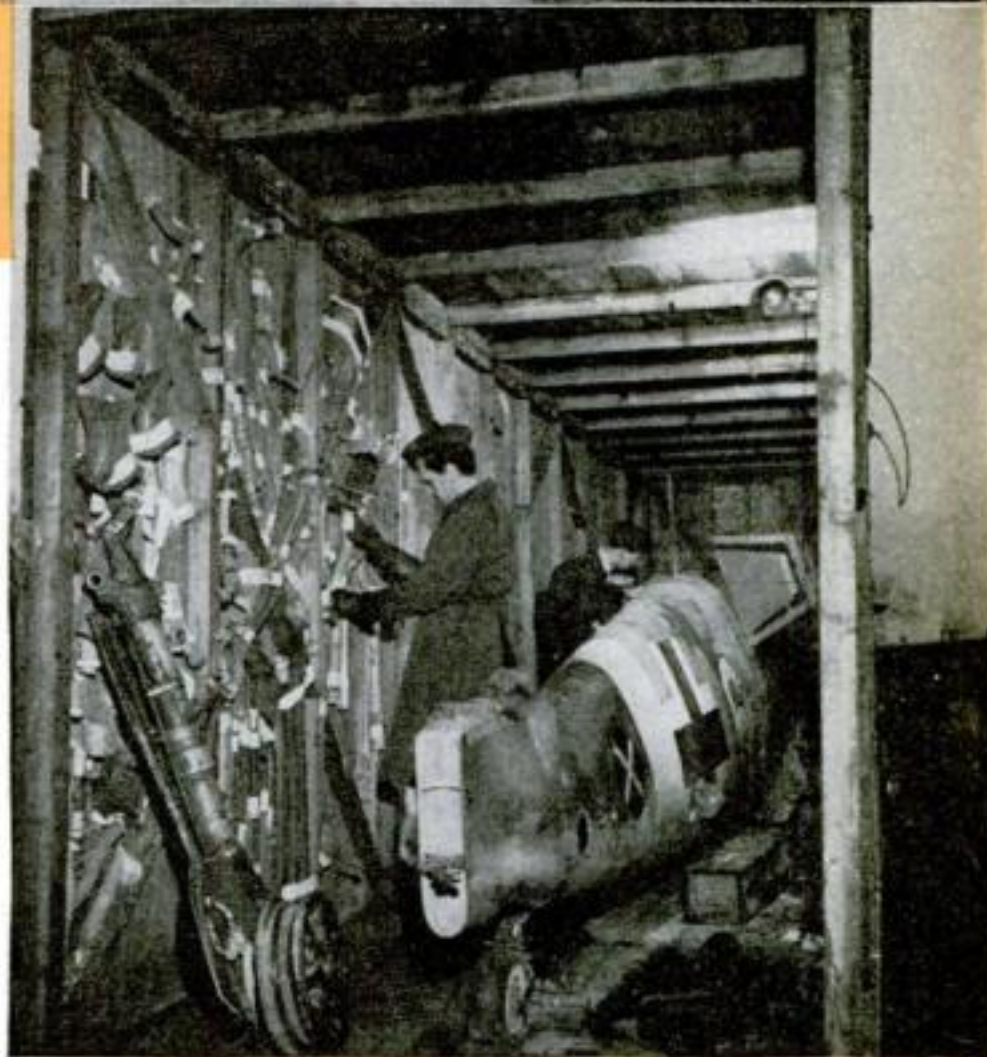
Photographs by HAROLD KULICK

FROM AN RAF STATION IN ENGLAND.

WHAT every Allied pilot first wants to know about any captured German airplane is how to start the blamed thing. Whether any American or British pilot ever has escaped from Germany in a stolen aircraft is something nobody is telling; but, naturally, the idea is a good one.

Instructions in this and answers to other pertinent questions are being provided today in the most effective way—by a flying circus of RAF pilots who make the rounds of American and British stations in captured enemy airplanes, giving actual demonstrations of their characteristics.

Probably the only British flyer alive who jauntily wears the swastika wings of a *Luftwaffe* pilot along with his RAF pilot's insignia is Flight Lieutenant E. R. Lewendon, who leads this "Rafwaffe" around the country, flying the latest type of Messerschmitt-109G. But you may be sure he is very thankful to have his dainty little fighter craft painted with the British insignia and



The North African war theater proved the best hunting ground for capturing Nazi planes that were still flyable. The ships, like this ME-109G, were dismantled and then crated for shipment to England

emblazoned on the underside with the bright yellow of a noncombatant aircraft.

Lewendon and some of his mates have been flying enemy planes around their own country for more than two years now, but have never been shot at. They take a Spitfire escort along with them, and observers on the way are warned not to judge too much from profiles. The procession includes, besides the ME-109G, a Focke-Wulf 190, a Junkers 88, and an ME-110.

The main risk about the job is that these planes may fall apart at any time. Spare parts are to be obtained only from other captured equipment, and the planes are



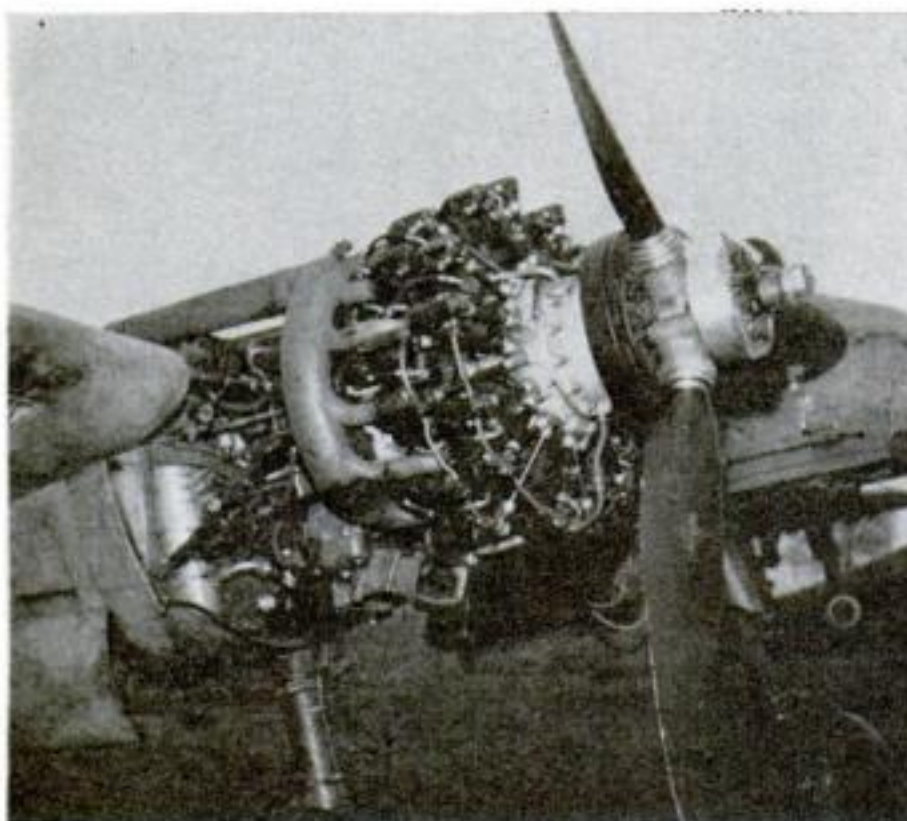
This Henschel 129 was captured in the African campaign. A low-level attack ship, it carries both 20 and 30-mm. cannon for anti-tank work. Allied pilots, having battered the day-lights out of the Gnome-Rhone works with 12,000-pound bombs, don't look for many more Henschels

HS 129

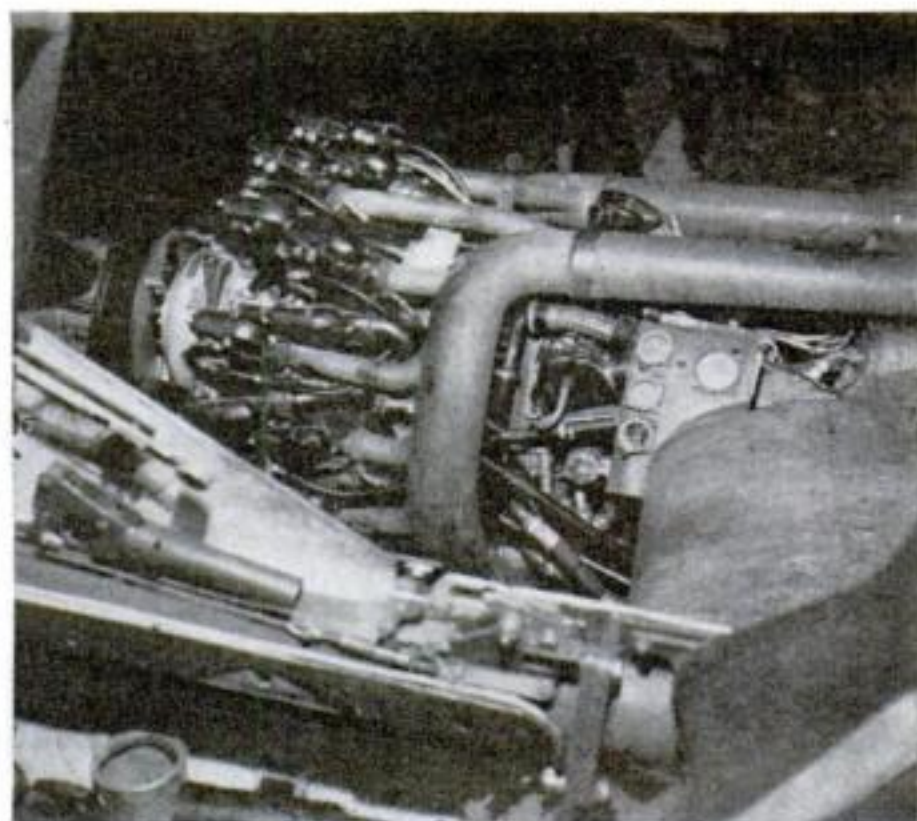


This head-on view of the Henschel, with its cowling removed, shows the elaborate wiring system located directly under the pilot. Two braces, one on each side, each hold a 20-mm. cannon for use on our tanks

In this view of the cockpit, notice the gear for the joystick. Other controls on the ship are also gear-operated. In refitting the ships for the "Rafwaffe," British dials were used so that the pilots could read the recordings in English



For its power plant, the Henschel carries two radial 14-cylinder Gnome-Rhone engines. Cylinders, however, are almost motorcycle size and generate only 850 hp. Propellers are also of French make



The right engine as it appears from the cockpit. As is usual with most German twin-engine planes, the Henschel carries such dials as the tachometer and fuel gauge on the inner side of each engine

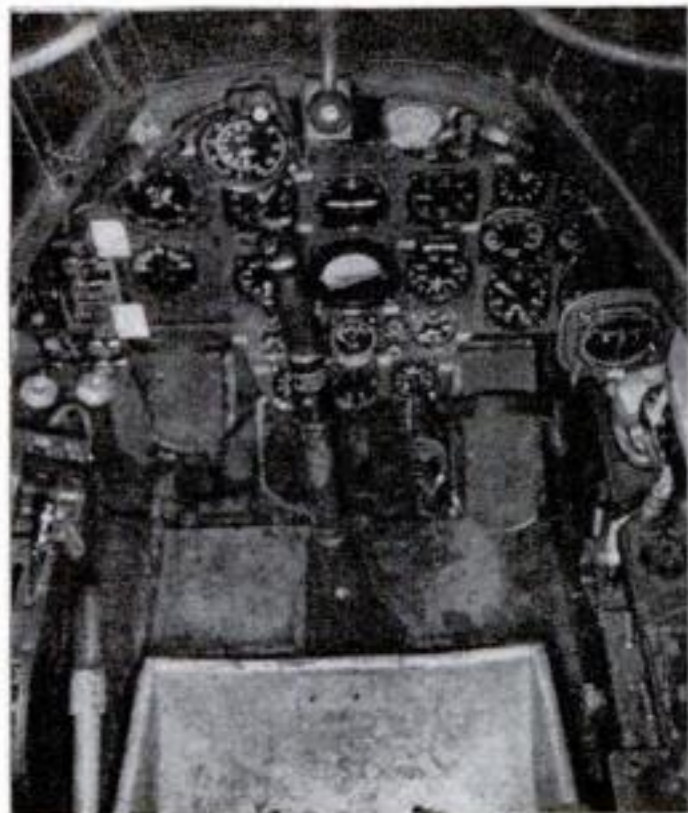
often U/S (RAF language for "unservicable") because replacements are not available. One trouble is with tails becoming loose. Instead of trim tabs, these German aircraft have adjustable tail surfaces which are shifted as a whole by hydraulic power. In this outfit's ME-110, the tail has become so wobbly that it seems likely to drop off, a failing which the aircraft has shown in combat.

Back in the days of the Battle of Britain, many of the 110's (twin-engine fighters carrying a crew of two) were shot down in England, but now their fighting ground is mostly over Germany itself, where newer versions of the 110 employ rockets against our Fortresses. At one time the best hunting grounds for capturing enemy aircraft that were still flyable were North Africa and the Middle East, where the ships were



ME 110

Manned by a two or three-man crew and well armed, the ME-110 is Germany's best twin-engine fighter. It has one weakness, however. In fast flight its tail is likely to come loose. Latest versions combat our Fortresses with rockets



The instruments on the dashboard confronting the pilot of an ME-110, one of the units of the "Rafwaffe" that are taken on the rounds of American and British air stations for instruction



Among the items of armament for the ME-110 is this flexible machine gun, a weapon of 7.9-mm. caliber, designated as MG-15. The "Rauchen Verboten" sign, which means "no smoking," is also Nazi

dismantled and crated for shipment home.

They seem strangely harmless when rebuilt for demonstration flying. For instance, the ME-109G, most feared of German fighters at high altitude, is a dainty little lady whose 32½-foot wing span would hardly seem to pack so much firepower. She is skittish too, with her landing gear set so narrow that she is subject to very tricky ground-looping if landed any way except directly into the wind.

This over-narrow landing gear apparently results from the fact that the 109 was originally designed to carry cannon in its light wings. Because that armament caused wing flutter, however, the guns were shifted. It now carries one nose-mounted 20-mm. cannon, extending through the shaft of the propeller, and back through the inverted-V of the 1,530-hp. Daimler-Benz engine. The butt end of the gun comes right back between the pilot's knees. The ship also has two 7.9-mm. guns (about ¼ inch) set in recesses atop the plane's nose and firing through the propeller.

A favorite for flying by the RAF pilots is the Focke-Wulf 190, which has splendid aileron control and the ability to roll any way you like. It has an automatic control box which sets the boost, mixture, airscrew pitch, and revs, and keeps them always adjusted to the throttle opening. The wide-set undercarriage makes landings easy.

An important part of demonstrations with

the FW-190, fastest German fighter below 20,000 feet, is diving at bomber crews so that they can see just what it looks like at that angle. Its radial engine gives it an appearance which often causes it to be confused with our Thunderbolt, although its bulge does not belly down below the wing. This air-cooled engine (a 1,650-hp. VMW-801, with 14 cylinders set in two banks) has a fan that sits behind the propeller and turns three times as fast.

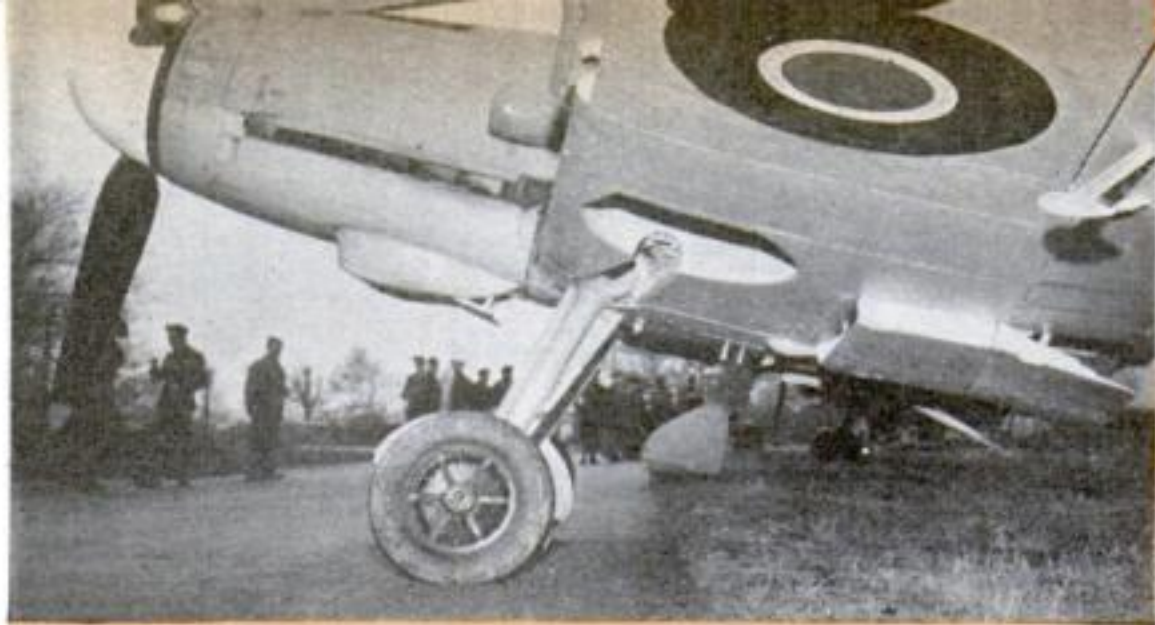
American flyers always cluster around the Junkers 88, which they fear very much in combat and admire for its versatility and maneuverability. It is used as a reconnaissance plane, bomber, dive-bomber, day and night fighter, and rocket ship. One amazing thing about this Junkers is that its crew of four men is able to function in its crowded cockpit, which has a downward swelling on the right side, like a jaw with a bad toothache. The radio operator (who handles two guns) sits back-to-back with the pilot at the left; the navigator sits at the pilot's right, where he can climb down into the nose for bombing, while another gunner stows himself as best he can behind the navigator in the rear of the protuberance, which opens as a hatchway. Notable in the 88's appearance are the two engines, which look like radials but are really inverted-V 12-cylinder engines. They get their radial appearance from radiators set around the propeller shaft. Its propellers are not con-

stant speed, but highly variable, and electrically controlled. The 88's controls are light as a feather.

Being prepared for inclusion in the flying circus is a Henschel 129, recently received from the Middle East. It is something of a curiosity because of the tiny motorcycle size of its engine cylinders. It has two radial Gnome-Rhone engines of 14 cylinders each, but only 850 horsepower. Contrasting with its small engine power is its heavy armor and powerful armament. For tank-busting it has two 20-mm. cannon, two 13-mm. guns, and a 30-mm. cannon that is slung under its belly for use in place of bombs.

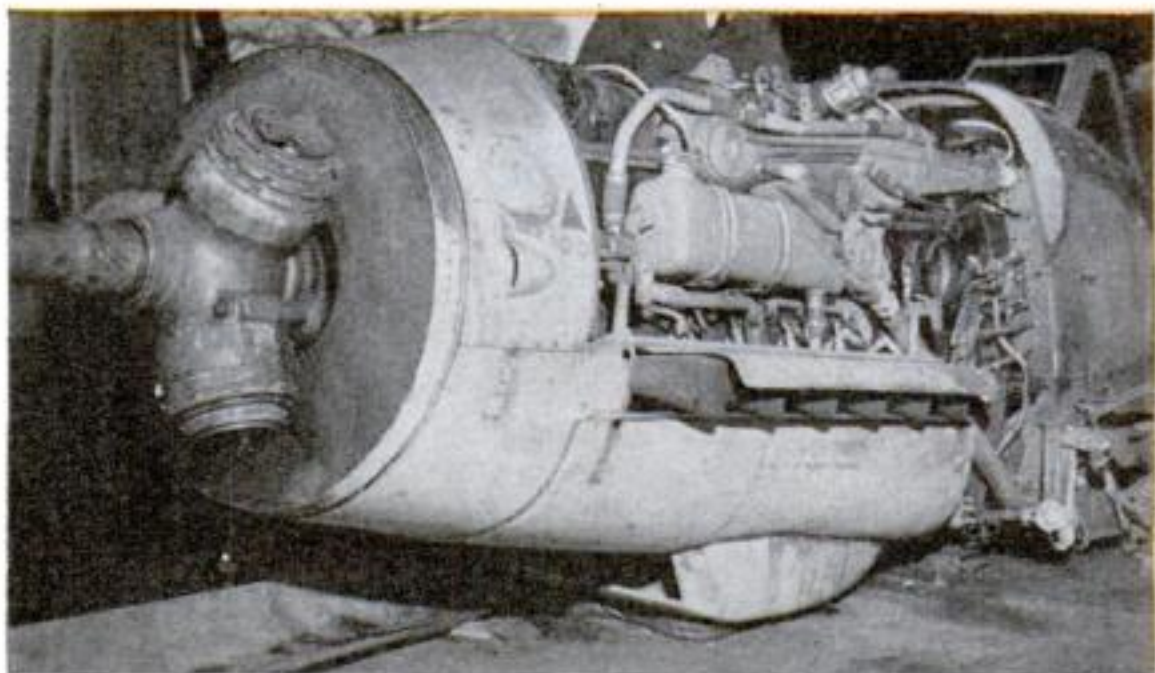
Probably not many of these Henschels are being produced nowadays. For it was on the Gnome-Rhone engine works in France that the RAF recently tried out its new 12,000-pound bombs, with ruinous effect.

All this demonstration of how enemy aircraft compare with our own is, of course, extremely interesting to the men who meet them in combat. It also serves a very useful purpose by providing flying hours in strange planes. Captured airplanes are given the most rigid examination and study by specialists before they ever get to Lewendon's flying circus, but steady flying usually brings out additional details of the utmost value.



Landing wheels of the ME-109G retract outward to the wings into wells, one of which is shown at the center of the picture. Above this well, in the wing's leading edge, is one of the slots which, when open, direct air flow so as to prevent stalling during a slow landing

An inverted Daimler-Benz 1,530-hp. engine from an ME-109G. Position is aid to pilot's field of vision owing to the triangular shape of engine. Nazi planes now carry a number of instructional markings which serve to assist inexperienced mechanics in assembling the ships



**FW
190**

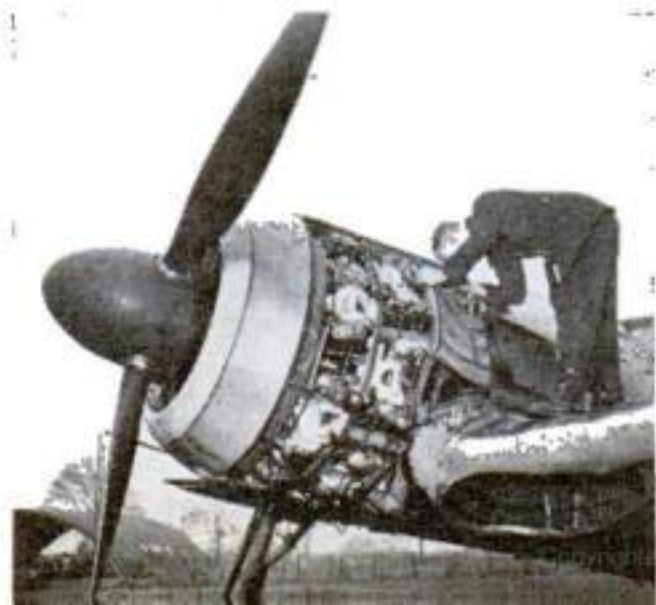
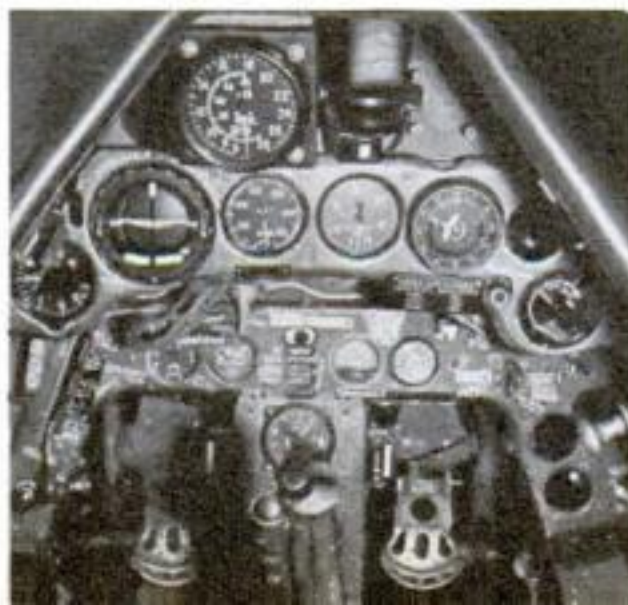
This front view of the FW-190 shows the rotating cooling fans that force air through the cylinders of the engine. The horsepower of this engine is 1,600 to 1,800



Used on the German FW-190 and ME-109G, this 7.9-mm. machine gun fires through the cowling or wing mounts. It is similar to our .30 cal.

The cockpit of the FW-190 has many more instruments on dashboard than the simpler ME-109

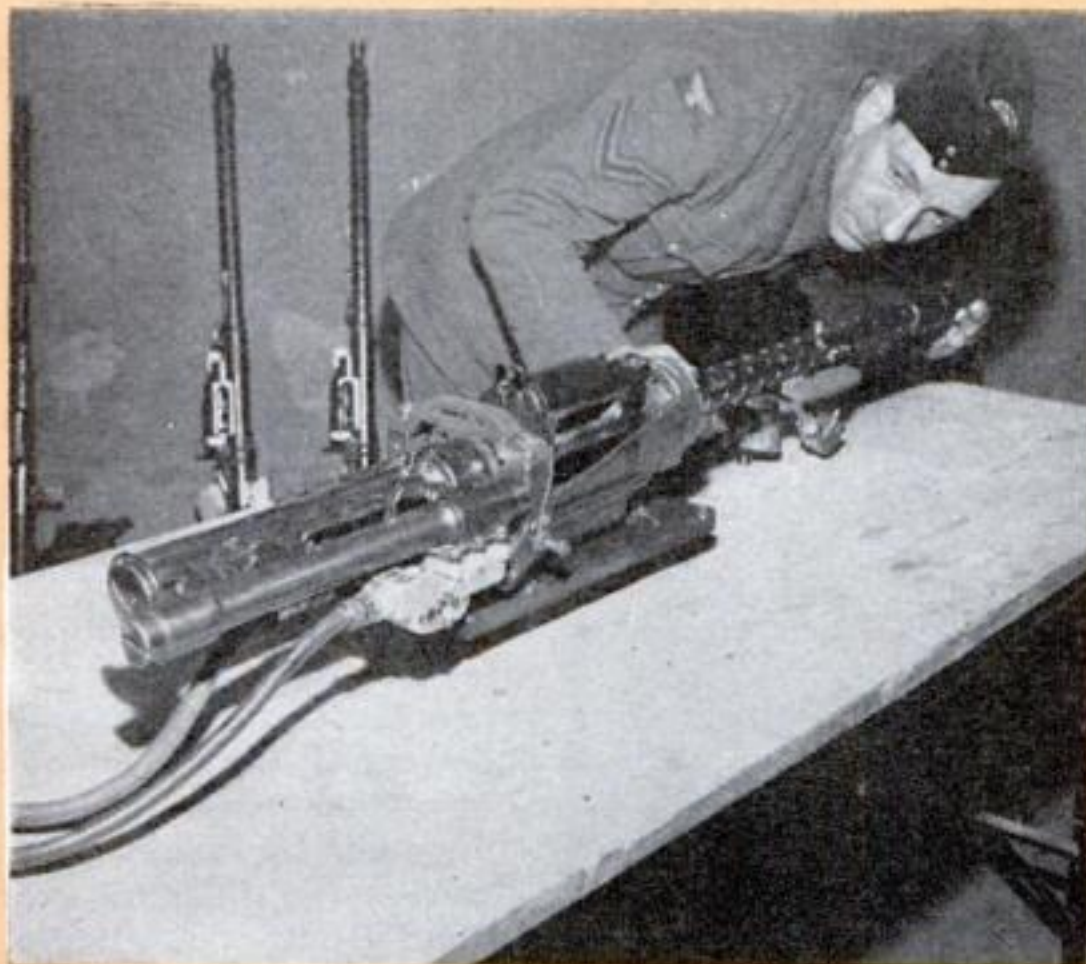
Compact engine of the FW-190 enables plane to travel 370 miles an hour at 17,000 feet



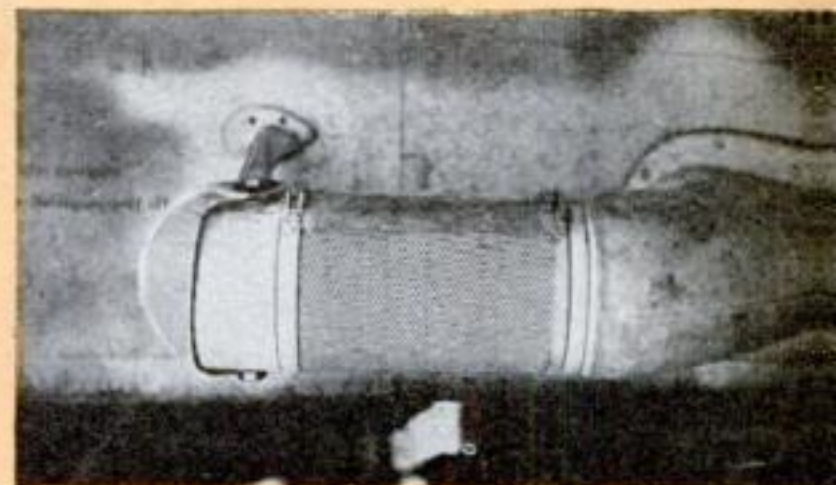
Side view of the ME-109G, a very tough fighter at high altitudes. It packs machine guns in its wings, a 20-mm. cannon that juts through the propeller hub, and two 7.9-mm. guns that fire through the propeller



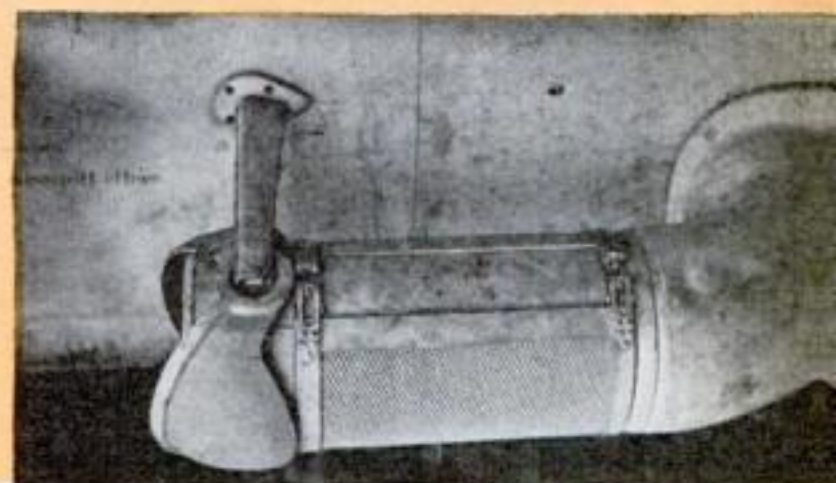
**ME
109G**



Member of the "Rafwaffe" examines a 15-mm. machine gun with the designation MG-131. This is part of the armament used on the Messerschmitt 109F in place of cannon. Such equipment from captured German planes is carefully studied and then explained to Allied flyers when it is taken on tour for display



The intake for the supercharger on an ME-109. The picture above shows it closed, while below it is shown in the open position. It is automatic in action, is used for desert warfare, and has a sand filter that keeps dust particles from entering supercharger housing and clogging motor



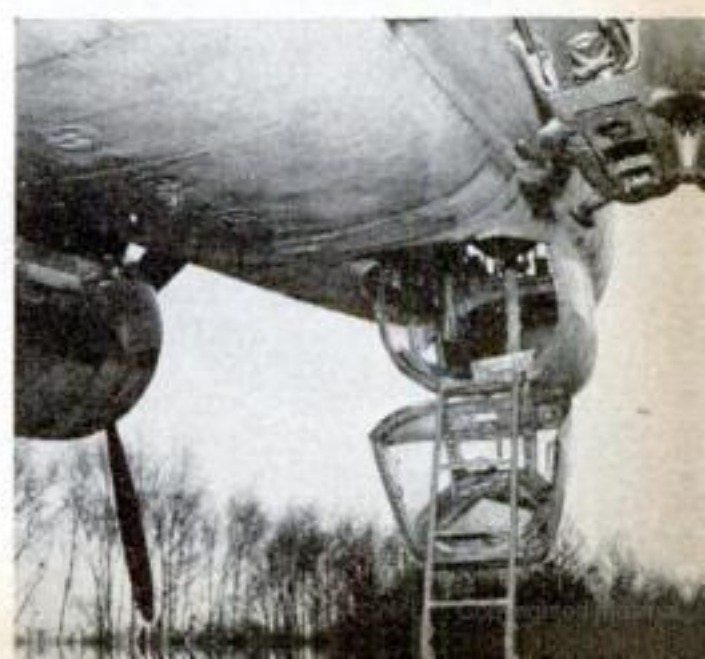
**JU
88**

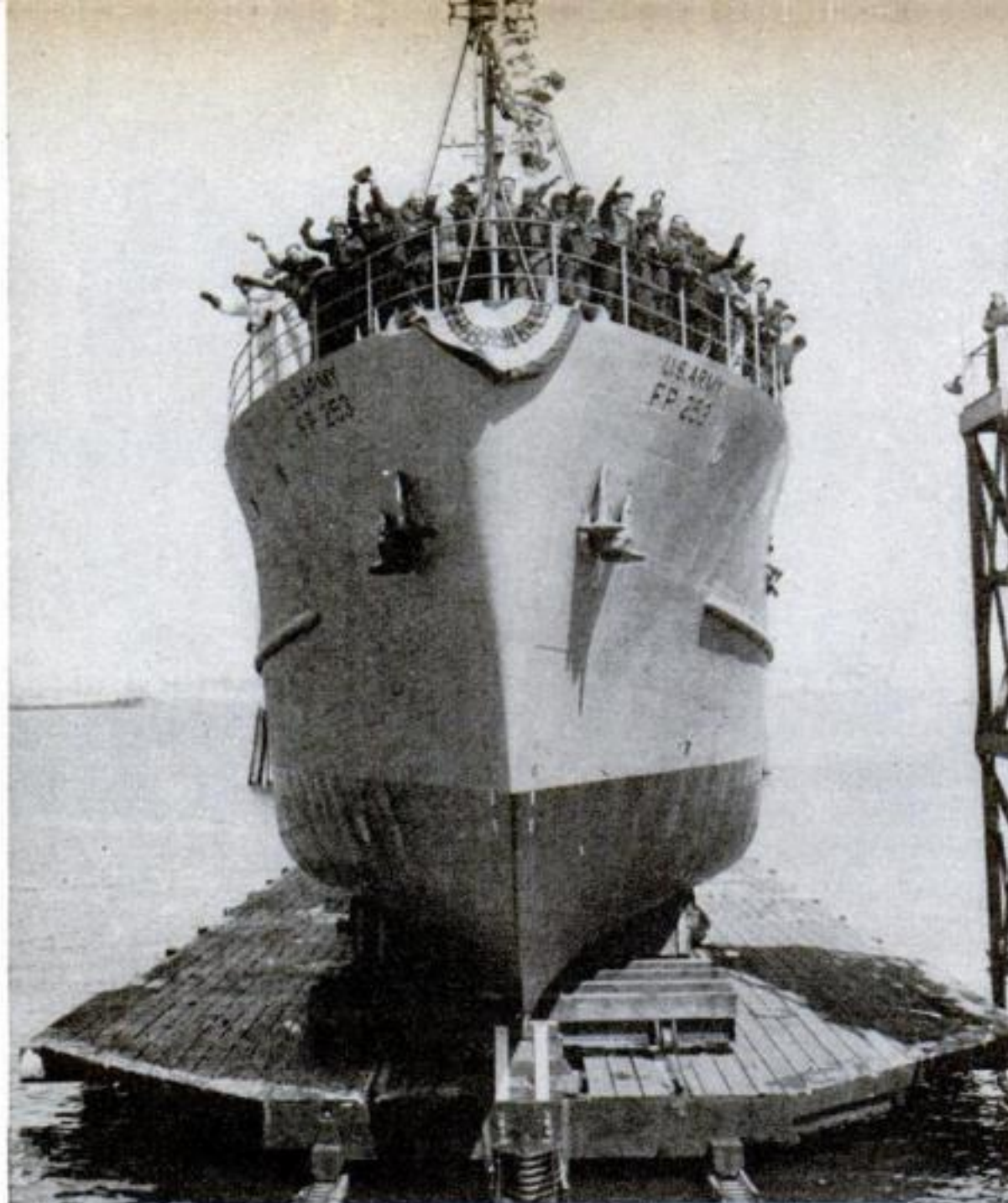
A nose view of the cockpit of the JU-88, which has its glass housing built in sections instead of being molded, as ours is. Under the housing is the little cupola that holds the bomb-sight and admits the crew



The JU-88 is one of Germany's foremost bombers, carrying a four-man crew, all in the forward compartment. It has two inline Daimler-Benz engines

How the crew reaches the cockpit of the JU-88. To the upper right is a rack capable of carrying a 500-kilogram bomb, which is slightly over 1,100 pounds





PLATFORM LAUNCHING. Unprecedented production of American ships during the war emergency has resulted in new, and sometimes surprising, methods to meet special conditions. Even the technique of launching—long a matter of choice between the fore-and-aft and sideways methods—has been given a new twist.

Raft launching is the new way of putting a vessel into the water for the first time. The U. S. Army FP 253 was built for the Army Transportation Corps, and firmly blocked on a platform, which was mounted on runways. When the time came for launching, the platform bearing the ship was slid down the ways by means of cables paid out from winches. On reaching deep water, the platform was floated out.

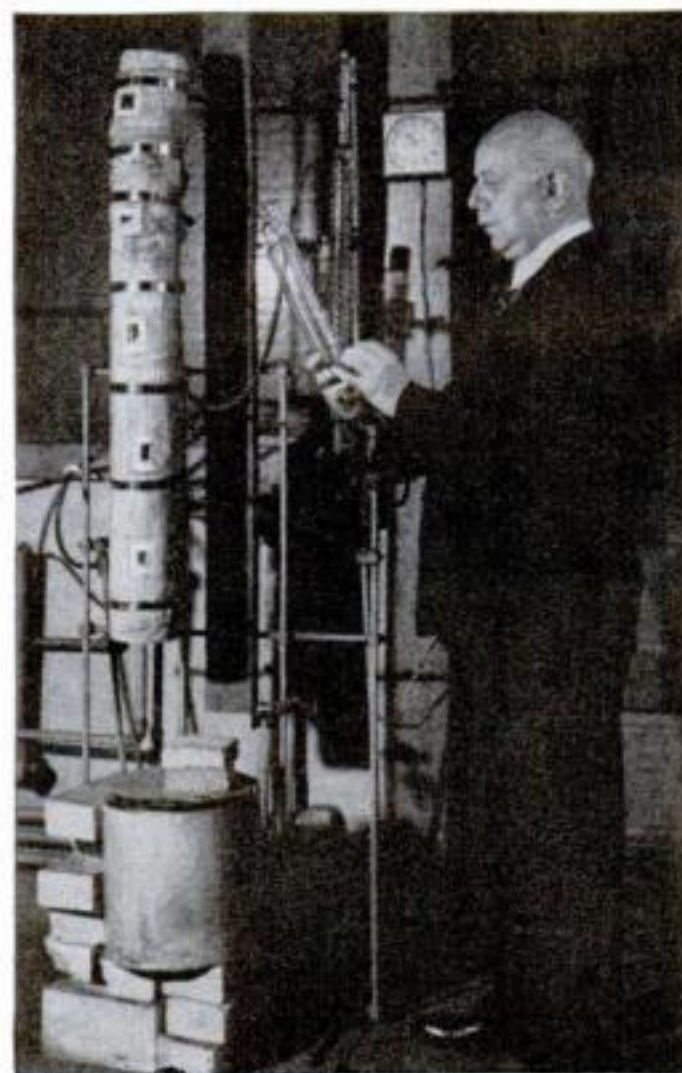


MATCHBOX COMPASS

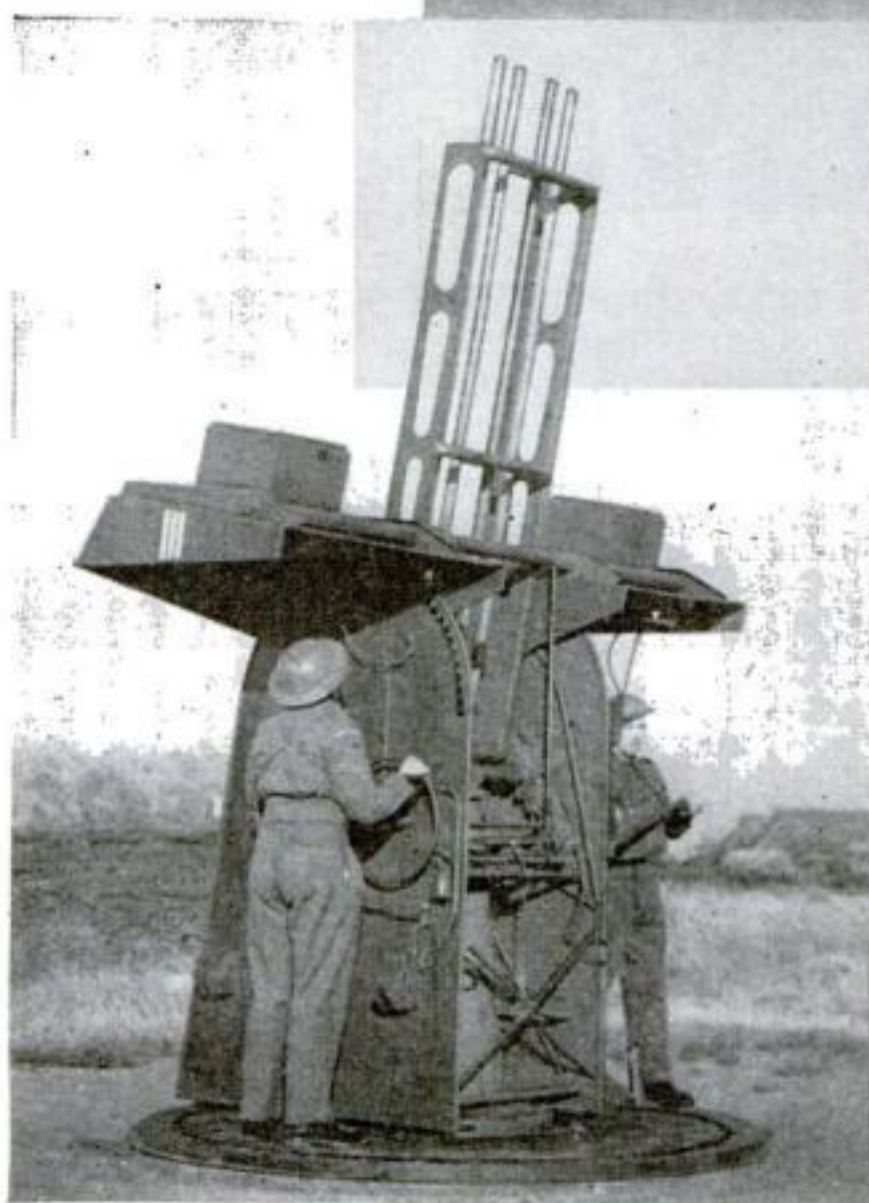
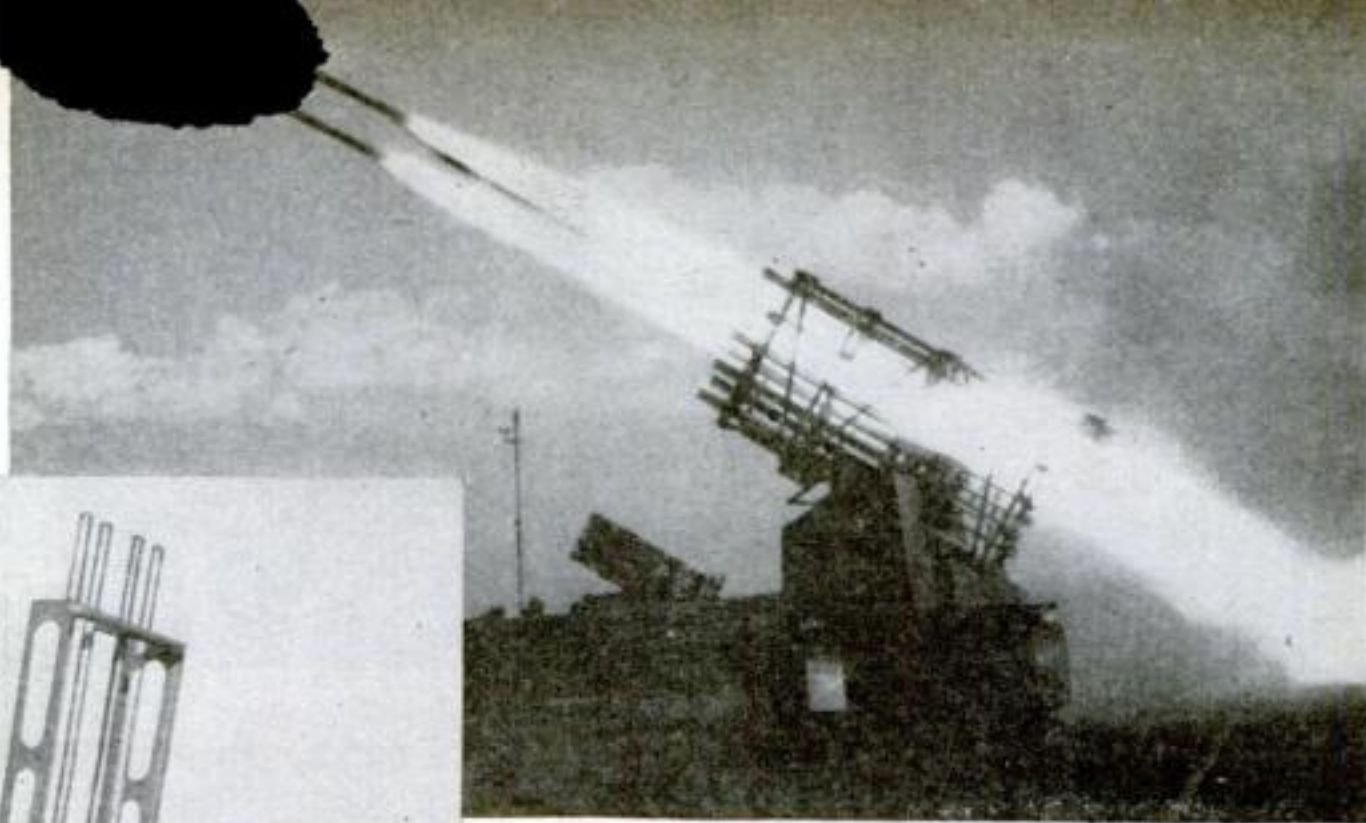
consists of a waterproof Bakelite plastic holder for matches, a striker bar at the base to produce sparks if the supply is exhausted, and a compass at the top of the cover. The container is designed for rough handling in Army and Navy use, and is a product of the Taylor Instrument Companies, of Rochester, N. Y.

GROWING OUR OWN GAS may be the answer to the problems posed by the demands of war and increasing industrial and personal needs. Startling results have been achieved by Dr. E. Berl, a research professor at the Carnegie Institute of Technology, from his experiments in converting plants into gasoline, coal, and other hydrocarbons. By carefully controlled internal combustion, plant material such as sugar cane, wood, sorghum, potatoes, cornstalks, or even grass, is transformed into a substance known as "protoproduct."

A gummy semiliquid at ordinary temperatures, this protoproduct is itself a highly efficient fuel. Hydrogenation converts it in turn into gasoline, kerosene, or lubricating oil. Or by another process it can be changed into coal that is said to be in some respects superior to natural coal. If Dr. Berl's method proves practical on a commercial scale, it may be of world-changing importance, for vast agricultural areas might easily produce their own fuel for industrial power.

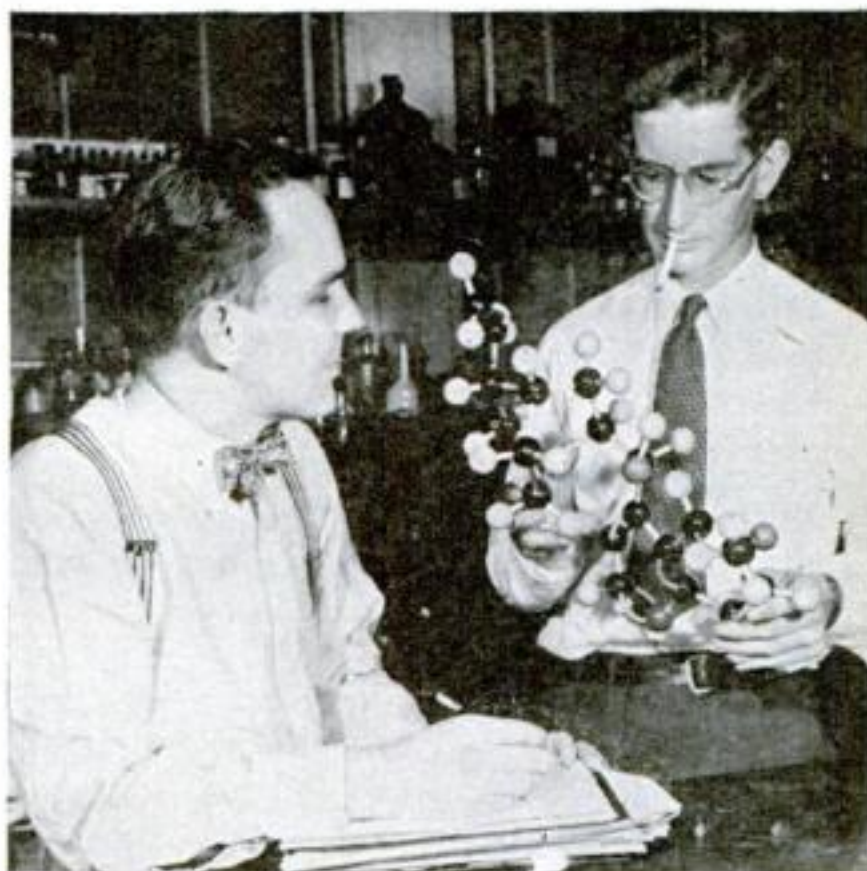


A multiple-barreled anti-aircraft rocket gun goes into action from a mobile mounting. Similar gun pictured below gives an idea of wide range of elevations possible



ANTI-AIRCRAFT ROCKET GUNS, used by the British against the *Luftwaffe*, are shown clearly in these photos, which are the latest and best to reach this country. The rockets make a terrific "whoosh" when fired at marauding planes, but Londoners are getting accustomed to the noise. The best-known rocket weapon used by American forces is the now famous bazooka (P.S.M., Dec. '43, p. 68).

FIREPROOF UPHOLSTERY of plastic-coated material developed by the United States Rubber Co. has passed such rigid tests that it is now mandatory equipment on all U. S. Navy combat ships. Tests included suspending the material for 12 seconds in a Bunsen-burner flame; after it was removed, it burned less than two seconds. It proved resistant to high temperatures by being exposed for three hours to 180 deg. F. without becoming soft and tacky. At 40 degrees below zero it did not crack when sharply creased, nor did it show permeation or other ill effect after exposure to oil or gasoline. Further tests revealed its resistance to abrasives.



SYNTHETIC QUININE, chemically identical with the natural malaria drug, has at last been produced. Instead of the bark of the cinchona tree, cut off by Japanese occupation of the Dutch East Indies, an abundant coal-tar product called benzaldehyde is the raw material. More than 15 delicate chemical manipulations shuffle the atoms of the benzaldehyde molecule into the new pattern of the quinine molecule, represented by the model held above by Dr. Robert B. Woodward, codiscoverer with Dr. William E. Doering (seated).



BAFFLES for radio-location devices, consisting of silver-and-black paper strips, have been dropped in night attacks by both British and German bomber and fighter planes. Aluminum foil laminated to thin paper and cut into strips of different lengths constitutes the anti-radar device.



First used by the British, these foil strips have been copied by the Nazis. Tossed from an elevation of 30,000 feet, the strips take about two hours to reach the ground. At first, aluminum foil alone was used, but it had a tendency to fall too rapidly in bunches. The paper backing prevents this. The tinsel is dropped in bales, which the wind tears open, permitting the strips to disperse and drift downward. The strips are .0008 inch thick, and range in width from 1/16 to 1/4 inch. The drifting metal, by presenting an artificial target for radio-directed ack-ack guns, enables the planes to avoid the line of fire. German children, picking up wisps of the material, have named it "angels' hair."

A COMPACT RESUSCITATOR has been developed by Dr. Joseph Kreiselman, Washington, D. C., and is now part of the safety equipment aboard American merchant-marine ships. The device consists of a bellows-type bag at the top of which is a strap for the operator's hand. The bag joins a rubber face mask by a plastic valve. Other valves allow intake of air and oxygen, and, by limiting pressure, prevent excess air from being pumped into the patient. A plastic elbow for the mask permits use of the resuscitator when the patient cannot be placed on his back.



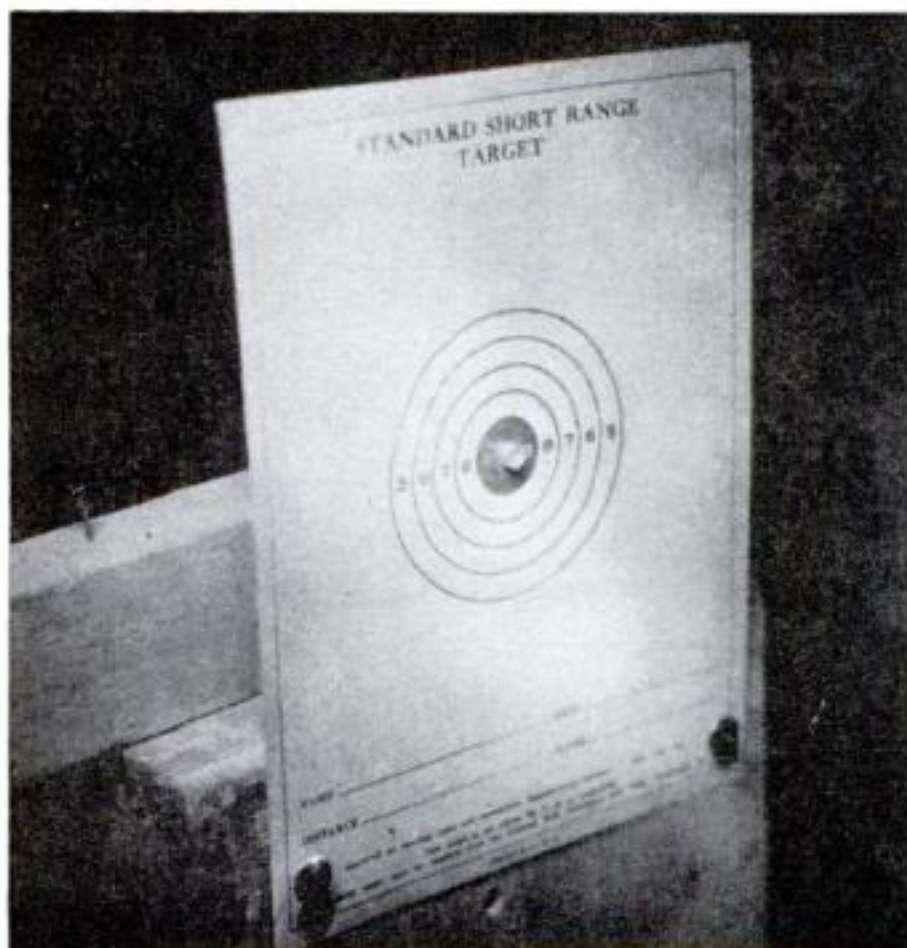
U. S. Maritime Commission Photograph

UNDERSEA CAVALRY charges the foe, in light diving suits astride a tiny submarine. This British human torpedo, operated by two men, penetrates enemy net defenses, creeps silently under water to a ship's hull, and attaches the war head of a torpedo. A time fuse allows for a getaway. One-man torpedoes used by Japs have made death inevitable for their operators. (Photo at left shows the diving suit used by the British.)



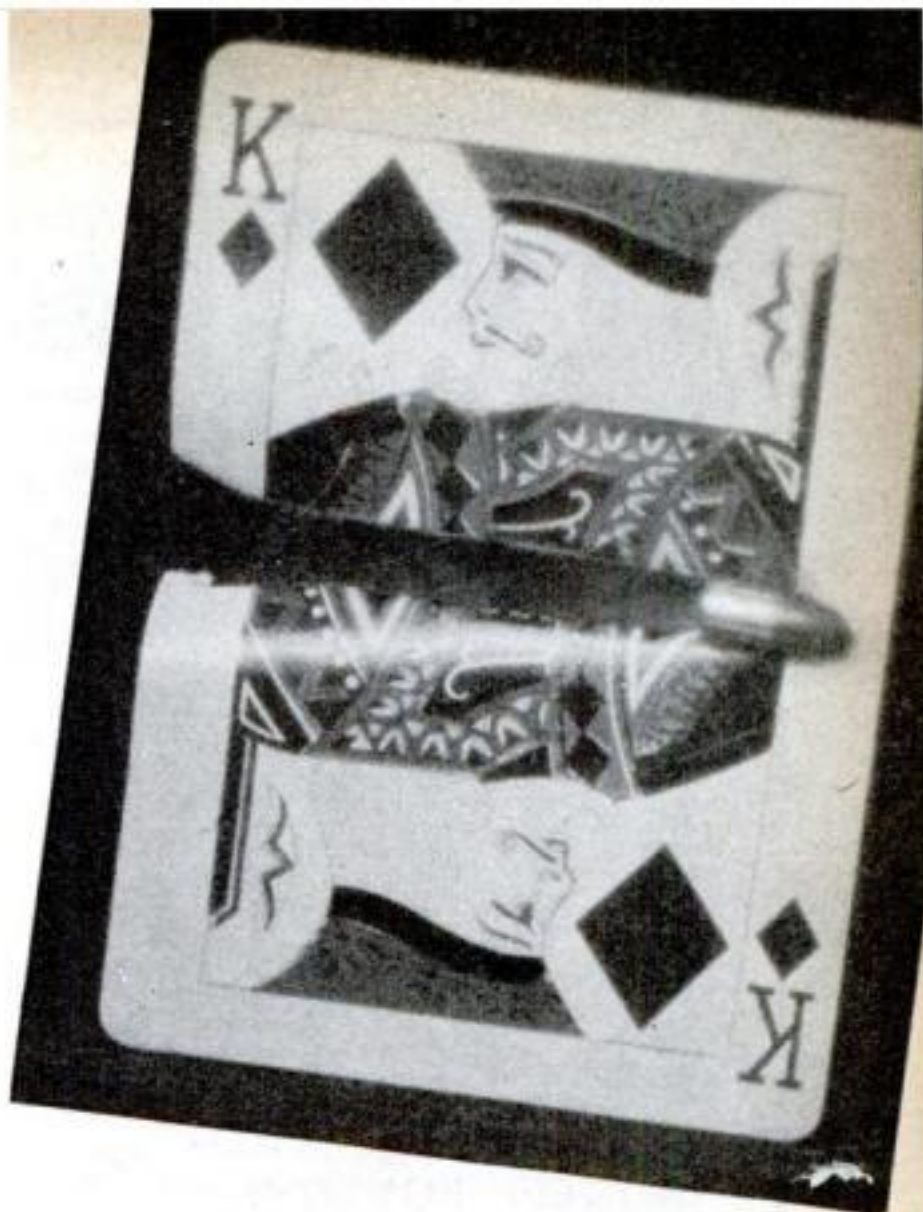
Camera Stops Army's .22

THE .22 caliber cartridge, recently graduated from the kindergarten of back-lot marksman, amusement-park shooting galleries, and schoolboy hunters, has taken its place on the list of important war matériel. Remington Arms Company is now turning out billions of improved .22's for use in preliminary marksmanship training. These inch-long cartridges, the use of which precedes that of the military .30 caliber variety, save labor and material and are an economical means of giving the new soldier the "feel" of a gun. The accompanying pictures, exposed one millionth of a second, show the bullets' effect and accuracy.



Stopped dead by high-speed photography at a millionth of a second, this .22 caliber bullet is still proceeding on its way through the bull's-eye. The gun was adjusted for aim so that the shot could not miss

Superspeed camera shows the impact effect of the little bullet on another kind of shell—this time a coconut. The quickness of shutter and lens action is indicated by the short distance milk has escaped



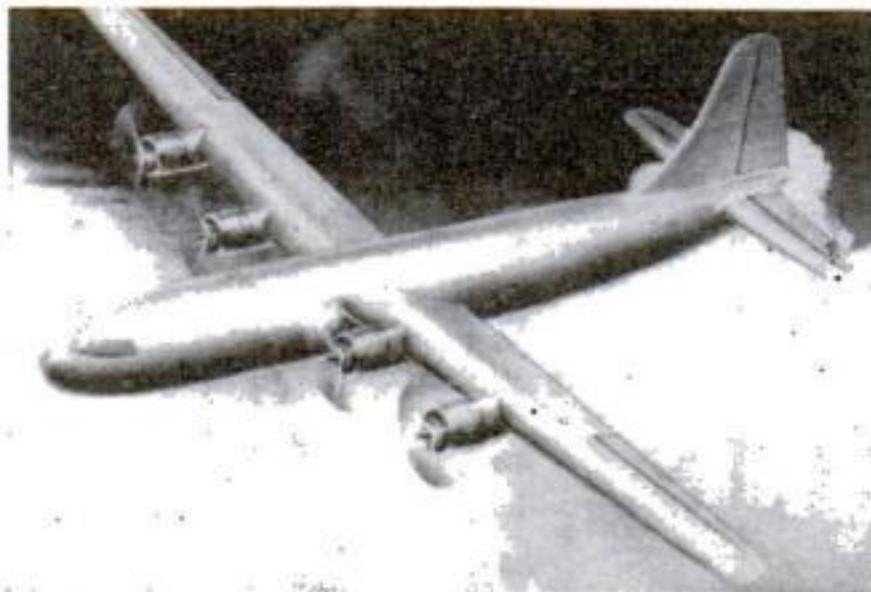
This remarkable photo shows a rifle-fired projectile moving at instantaneous speed from edge to edge of an ordinary playing card. The camera lens was even quicker



As a combination potato peeler and masher, the .22 seems, from the evidence here, to offer solace to K.P.'s in the mess kitchen. This picture of a spud target is a study in both ballistics and photography

Hitting power of the small-caliber bullet is demonstrated by a supersplit-second camera shot that stops even the tiniest flecks of foam spouting from the beer can. Note the cap at top of the geyser

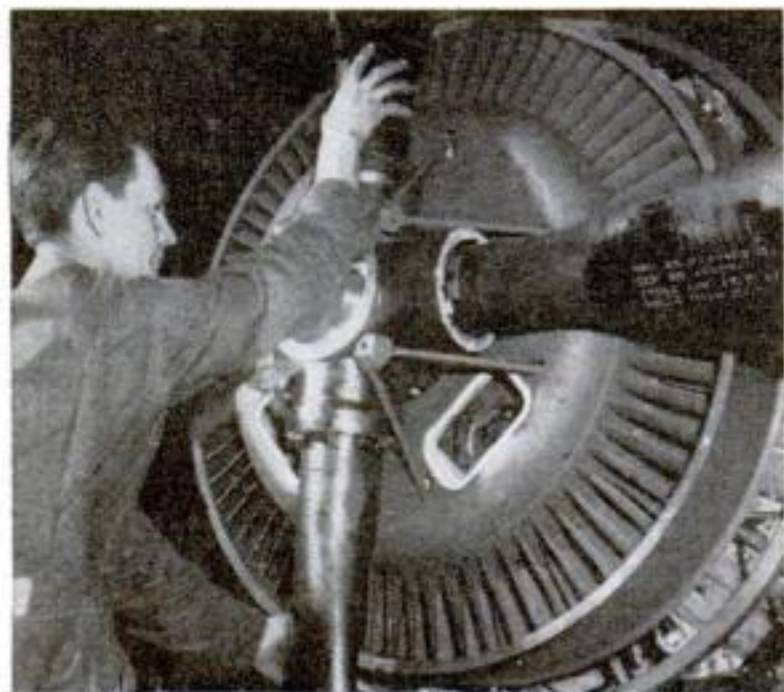




POSTWAR AIRLINER, Model 39 by Consolidated Vultee, has a 90-foot fuselage and the same wing and engines as the B-24 Liberator. It seats 48 persons in a spacious "club car of the clouds," accommodates 24 at night. Cruising speed is 240 m.p.h., and range, when fully loaded, 2,500 miles.

BIGGEST PONTONS

ever built, and carrying retractable wheels, now enable the huge Douglas C-47 to operate from land or water. The pontons, each of which is bigger than the fuselage of a P-40, also serve to carry part of the ship's fuel. Rudders on the pontons guide and brake the plane.



Mounted on the "prop" shaft just inside the cowling of this American dive bomber, the new fan conserves much of the engine's power that was formerly expended in overcoming drag from used-up air

FAN SAVES POWER. This new propeller-speed cooling fan, developed by Wright engineers, will boost the climbing rate of a plane 20 percent, add as much as 10,000 pounds to the payload of some twin-engined aircraft, and also increase cruising speeds and improve altitude performance. It fits just inside the cowling and sends air over the cooling fins of the engine. By driving out used cooling air, it largely eliminates its dragging effect. Engine can develop full horsepower without overheating.

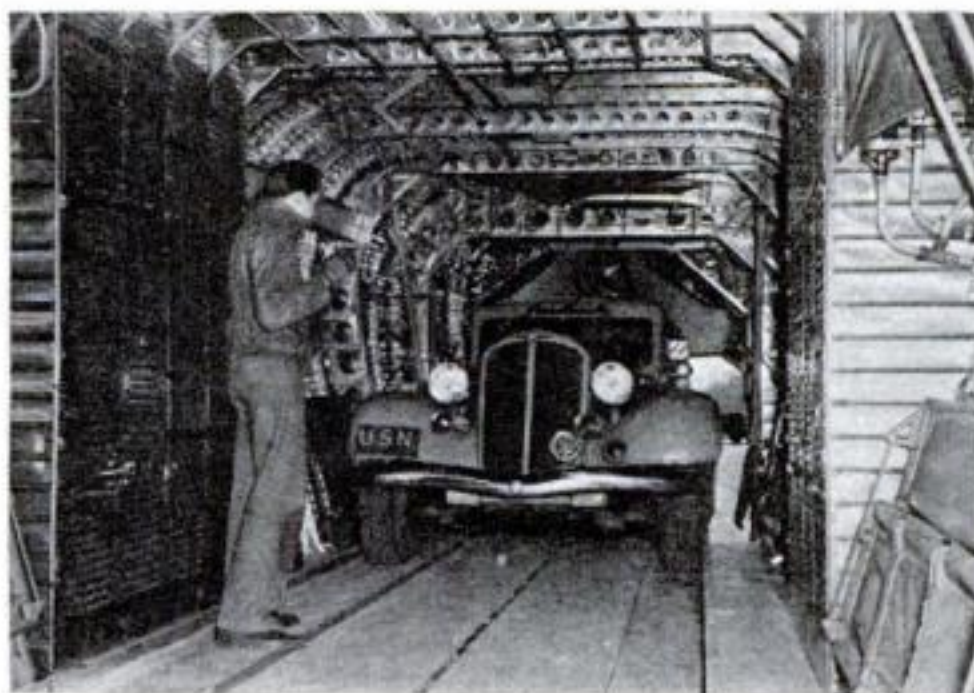




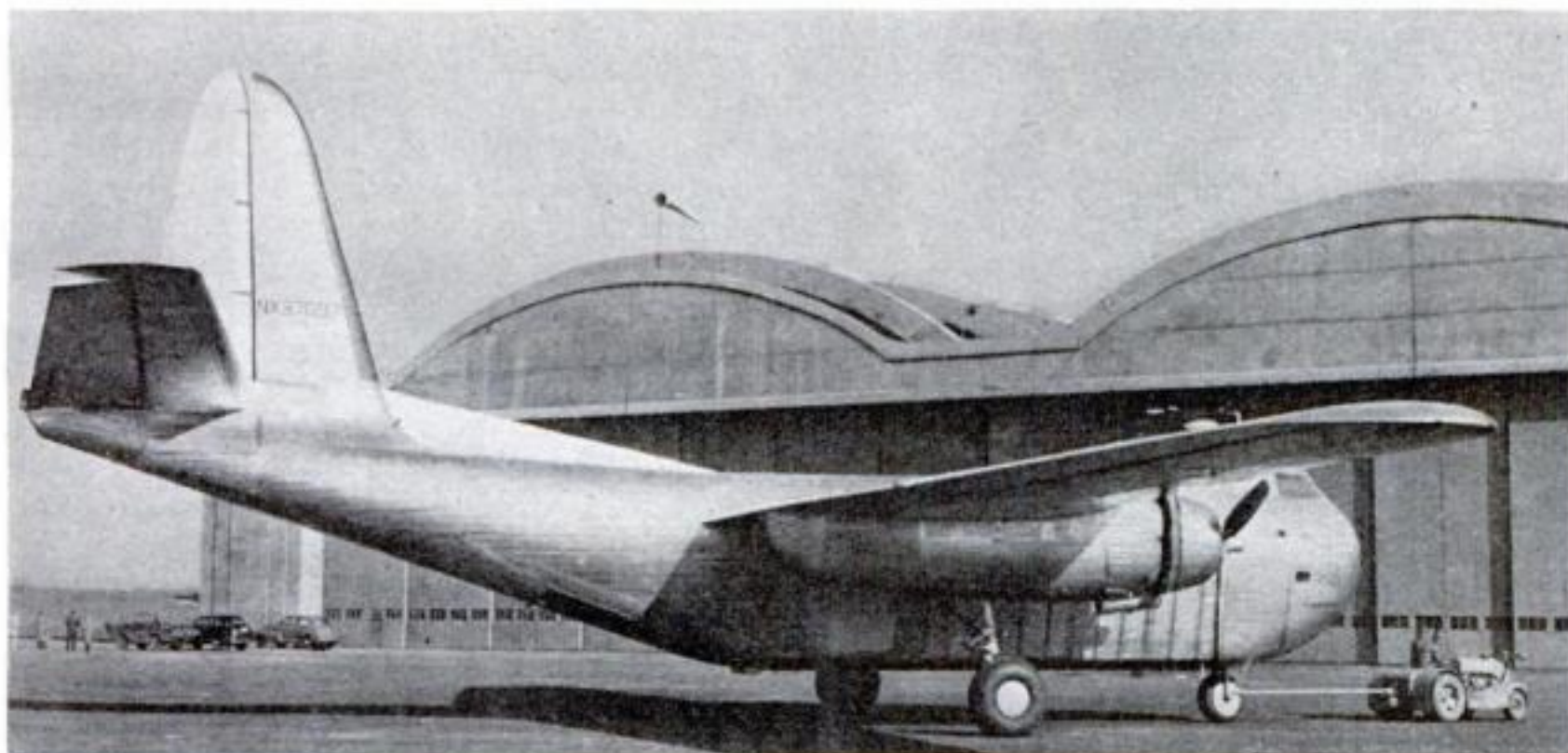
In paratroop operations, men hit the silk through doors at the sides while their equipment is dumped through a trap door in the tail. At left, an ambulance and a seagoing jeep drive up the ramp provided by lowering the underside of tail

First Stainless-Steel Plane

DESIGNED around a required cargo space of eight by eight by 25 feet, the world's first production-model all-stainless-steel plane is ferrying amazing loads of war cargo to many fronts for the U. S. Naval Air Transport Service. Named after the covered wagons of pioneer days, the RB-1 Conestoga was designed by Dr. Michael Watter and is built by the Edward G. Budd Manufacturing Company, of Philadelphia. Out of the big plane's total loaded weight of 33,800 pounds, 10,400 pounds—or nearly one third—is cargo.



Inside the big belly of the Conestoga, two vehicles can be stowed away with lots of room to spare for extra cargo. The amazing load-carrying space of eight by eight by 25 feet is made possible by the fact that the wing does not pass through the center of the fuselage. Two 14-cylinder engines, developing 1,200 horsepower each for take-off, lift the plane with over five tons of payload in a 920-foot run



These Are America's Real "Secret Weapons"

Our ability to design, produce, and deliver superior fighting equipment has been a surprise to the Germans and the Japs on every war front.

By MAJ. GEN. G. M. BARNES

Chief of Technical Division, Office of
Chief of Ordnance, U. S. Army

One dark night, a native French trooper on sentry duty at an important crossroad near a battle front saw a group of men approaching on foot. When he challenged them, they said they were Americans. He instantly killed them all with his submachine gun. They were German soldiers wearing American uniforms. When asked how he had known this, the sentry said: "That's easy. All Americans come in jeeps."

The quality and quantity of American ordnance—everything that rolls or shoots—have distinguished our troops increasingly. A German officer is credited with having said that a perfect army would have German infantry, American ordnance, and Italian music. Judging by recent efforts of German and Jap soldiers to hoard Garand rifles and other captured equipment, that officer's opinion is now widely shared.

The importance of ordnance has increased throughout history. Now our ordnance officers are the soldiers' servants, who supply them with all the tools of mechanized war, from bicycles to 38-ton tractors and from pistols to block-busters.

Maj. Gen. G. M. Barnes, chief of the U. S. Army Ordnance Department's Technical Division, is one of the world's foremost authorities on ordnance. Ever since he was graduated in engineering from the University of Michigan in 1910 and was commissioned in the Regular Army, he has been studying our own and other nations' arms. He was a special assistant to the chief ordnance officer of the AEF in the last war, and has directed the designing, testing, and production of improvements in old weapons and the development of our Army's new and secret weapons.

In this article, General Barnes points out highly significant differences between our weapons and those of our foes. It is not intended in this article to imply that our American soldiers are not facing strong and determined enemies armed with lethal weapons, but rather to inform mothers, fathers, wives, and relatives here at home that our men are expertly armed with every essential weapon of war to give them that edge in combat necessary for victory.

DO YOU recall the universal awe with which this country—only two years ago—viewed the efficiency of the German Army and its mechanized equipment? Today, this same German Army does not seem quite so powerful or mysterious.

The United States, rather than Germany, now has the most comprehensive and modern line of ordnance in the world. Hitler's blitz weapons, with which he overran Europe, were designed and produced in the 1920's and 1930's. Germany's preparations for a scientific death struggle had been thorough, and her well-armed forces seemed irresistible at first. But now *we* are armed with later models of similar and additional weapons, and Americans are no longer either awed or baffled by the enemy.

Based on the developments of the preceding 20 years, most of our ordnance weapons were designed and placed in production in 1939 or later. The differences between our weapons and those of our foes, consequently, are comparable to those between a 1940 and a 1930 automobile.

The owner of a 1940 car may be run over and killed by a 1930 car. Similarly, the weapons of our foes are deadly. They have taken and will continue to take many American lives. We believe, however, that our weapons are more powerful and that this will become more evident as the war continues.

Our efforts in the Ordnance Department have been directed solely toward the perfecting and producing of the kind and number of weapons that our fighting men want. The men facing the foe are our customers, and, like good business men, we have proceeded on the theory that the customer is always right. No effort has been spared to provide our soldiers, wherever they are, with the best armament of the highest quality in adequate quantities.

How we achieved superiority in ordnance is a remarkable story. Only a few hundred pieces of American artillery were used at the front by the AEF in the last war. From 1920 to 1938, the United States spent an average of only \$12,000,000 a year on Army ordnance. Big guns sometimes rusted at the Aberdeen Proving Ground, Maryland,



Photo by William W. Morris

PRODUCTION. Acres of massed weapons such as these M-4 tanks are parked on both sides of the Atlantic. From a single East Coast depot, more than 100,000 vehicles of 125 different types have been sent overseas. A tank is delivered like a new car, complete with instruction manuals, tools, and equipment in a watertight box that contains everything from asbestos gloves to crowbars. Tools are treated to prevent rust

PACKAGING AND SHIPPING. Merely preparing American ordnance for shipment is a tremendous task. Below is a scene at the Chester Tank Depot near Philadelphia, operated by the Ford Motor Company (Neil Brown, general superintendent). This one depot has used as much as 220,000 board feet of lumber in a day. In the lower left-hand corner a crated truck is coming off the disassembly line. (See photos on pages 58-59)

Photo from Ford Motor Company





VEHICLES. Germany's volkswagen, at right above, is no match for our jeep. With only a two-wheel drive, it can't get around like our quarter-ton. Its top speed is 30 m.p.h., to the jeep's 50



Official Photographs, U. S. Army

GUNS. On the proving ground, as on the battlefields of Africa, the touted German 88-mm. gun is outclassed by the harder-hitting 105-mm. gun-howitzer mounted on our M-7 tank destroyer ("priest")

for lack of paint to protect them adequately.

Fortunately, however, our ordnance officers continued to study, design, try out, and perfect plans for new and better weapons. Many of those officers passed up better opportunities in other fields to serve their country in this way despite the widespread indifference to their work. Their time was well spent.

Each one of the Ordnance Department's 13 district procurement offices, established soon after the Armistice, consisted of only one regular officer and a secretary. Nevertheless, those offices, over a 20-year period, familiarized the Army with the war potentialities of factories throughout the country, and the Ordnance Department learned just what each important manufacturer could do best. Undoubtedly, this was the finest survey of the kind ever made of American industry.

When the President persuaded Congress,

in September 1940, to appropriate more than a billion dollars for ordnance, orders were spread across the country almost as fast as butter is spread on bread. In two weeks, \$1,250,000,000 worth of matériel was ordered—and these orders, for the finest possible equipment for our Army, were placed with those manufacturers best equipped to do the work.

The best ordnance is rarely invented overnight. It is developed, like commercial machines, through a series of models. There was an argument recently about who invented the jeep; there might be such arguments about many other ordnance items, for they represent many men's thinking and experience. Several of our most important weapons were redesigned just before we began mass production. Thus we armed ourselves with more up-to-date weapons than those which had been stored up by our foes.

The 105-millimeter howitzer, the back-



THE "BAR" IS THE

SUNDAY punch of the men who hunt Japs in South Pacific jungles is the death-spraying .30 caliber Browning Automatic Rifle—a weapon which has thrown such terror into the Nips that their snipers always shoot first at the man with the "BAR." For protection during his perilous work, the "BAR" man moves about with two men at his heels who keep him constantly covered with Garands. Spitting 350 bullets a minute on "slow fire" and 600 on "fast," the heavy "BAR," which also has a tendency to pull its muzzle upward

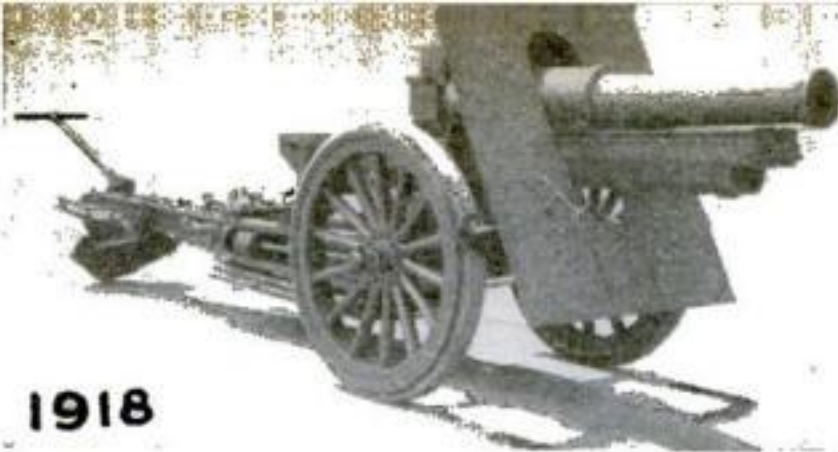
The BAR is loaded with a magazine containing 20 .30 caliber cartridges (the same as are used in the Garand rifle). The complete weapon weighs 19 pounds; the loaded magazine, about 1½ pounds

THE EVOLUTION OF OUR 155-MM. HOWITZER

Development of ordnance is typified by the improvements made in our 155-mm. howitzer since World War I. The present 155, which has nothing in common with earlier models except its caliber, can be moved faster and fired more efficiently than any other weapon of its type. A battery of 155's can race up to a position, halt, and open fire in less than eight minutes. Normal rate of fire is three rounds a minute per gun, but they can be fired faster. An important modification is the split trail with a spade to anchor each end. The gun's weight rests on three points for easy leveling—an advantage over German guns of similar types

bone of the artillery, is a good example of our further development of a familiar weapon. We had been building and improving this "workhorse of the Army" for many years, but we had only a couple of dozen 105-mm. howitzers early in 1939. These represented several models, each of which had been tested carefully. But we did not start mass production of any of these models. We began producing great quantities of a brand-new and better howitzer, which quickly became famous around the world.

This weapon can be elevated to 65 degrees, which permits almost vertical fire. My friend, Maj. Gen. Albert W. Waldron, who was severely wounded in the South Pacific, has told me that this improvement gave our troops a tremendous advantage over the Japs in the jungle. The enemy had specialized in light weapons for jungle warfare. But our *(Continued on page 58)*



1918



1940



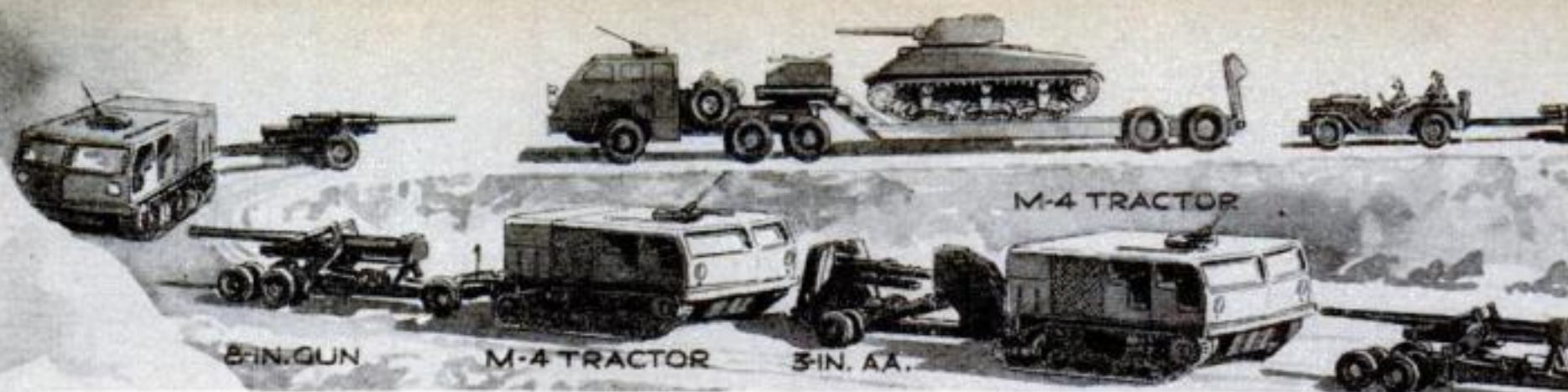
1942

SUNDAY PUNCH OF JUNGLE IN-FIGHTING

during prolonged bursts, calls for handling by a husky man. The gun can be fired from any position and has a metal clip which holds it steady to a soldier's shoulder while its bullets whip out at a muzzle velocity of 2,800 feet a second. Although its sight is calibrated up to 1,600 yards, the gun is used at short and medium ranges.

BAR team consists of an automatic rifleman and two men with Garands who protect him and carry reserve ammunition





TACTICAL VEHICLES AND THE GUNS THEY HAUL

Dr. Fritz Meske, a German military commentator, told radio listeners during the fighting in Italy: "The enemy's strength lies in his extremely extensive and variegated artillery." This parade shows only a part of America's vast assortment of weapons and their prime movers. Whether a rapier thrust is demanded, or a battle-ax blow to hack through enemy positions, our forces have the right weapons at hand. "The Ordnance Department," says Lt. Gen. Mark Clark, of the American Fifth Army, "has performed a tremendously fine task in keeping us supplied with arms and munitions." American productive genius has made this possible

155-MM. GUN



COMBAT VEHICLES

These sketches show some of the ways in which wheels and tracks carry our men and weapons into battle. One of the newest light combat vehicles is the M-8 armored car, which combines the speed and maneuverability of an automobile with the punch and protection of a light tank. Also new is the M-8 motor gun carriage with a 75-mm. howitzer designed for use against enemy personnel. It has the same chassis as the M-5 light tank. Amphibious vehicles have proved highly successful and their production has been increased. The half-tracks (right) exemplify the American plan of using a few basic vehicles in a wide variety of ways for easy field maintenance

LIGHT



WHEELED

SCOUT
CARM-8 ARMORED
CARM-51 MAXSON
QUADRUPLE
MACHINE-GUN
MOUNT

TRACKED

M-5 TANK
37-MM. GUNM-8 MOTOR
GUN CARRIAGE
75-MM. HOWITZERM-4
TRACTOR

HEAVY



WHEELED



DUCK

M-26 PRIME MOVER
FOR TANK-
RECOVERY UNITM-15 TANK-RECOVERY
UNIT
(M-26 + M-15 = M-25)

6-BOGIE TRACK



M-6 TRACTOR

M-12 MOTOR GUN
CARRIAGE (155MM.)M-4 TANK
(75-MM. GUN)M-10
TANK DESTROYERM-7
TANK DESTROYER

HEAVIER



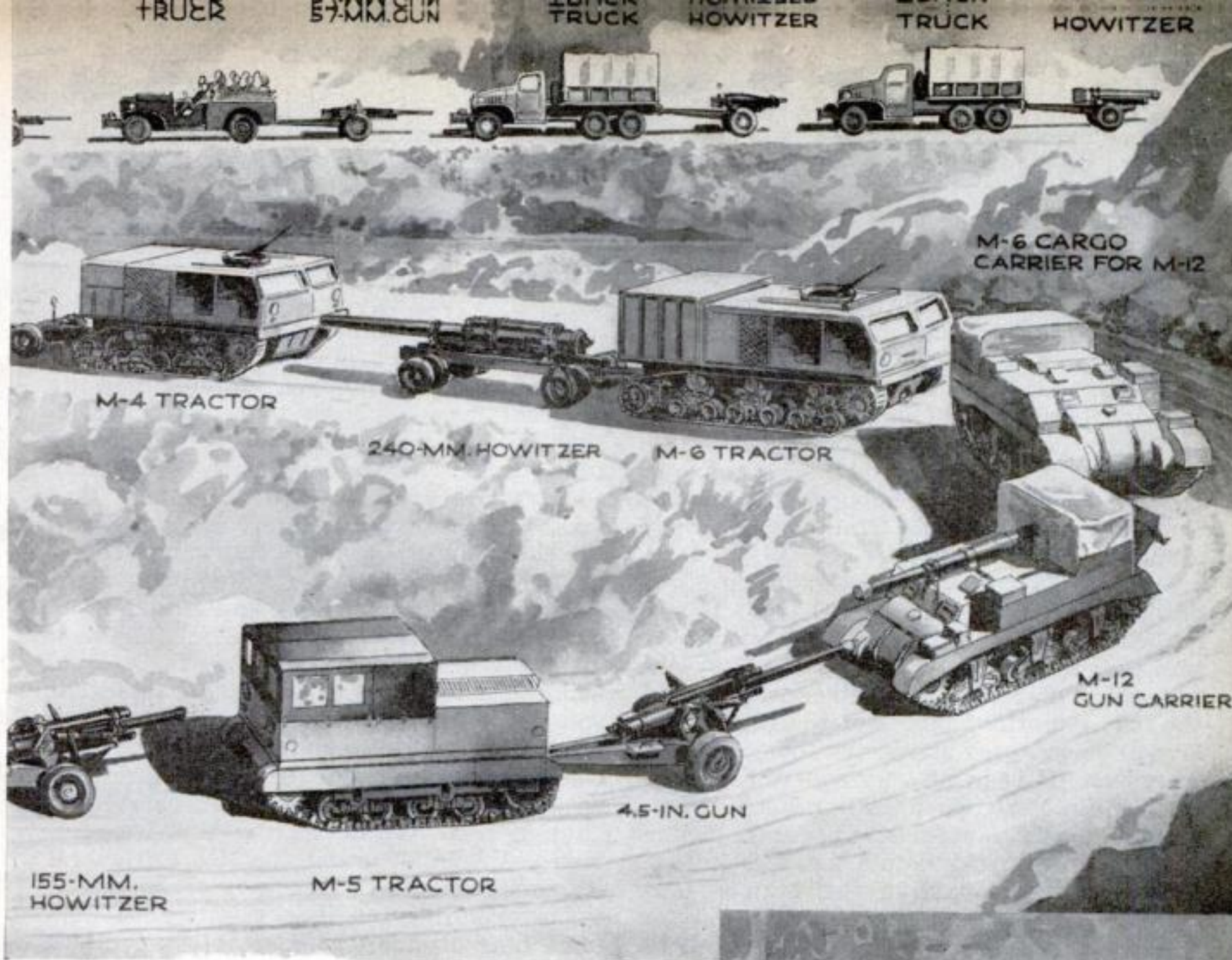
60-TON TANK



WATER BUFFALO



ALLIGATOR



Drawings by B. G. SEIELSTAD

HALF-TRACKS



HALF-TRACK



HALF-TRACK+.50 CAL. A.A.



PERSONNEL CARRIER



M-2A-1 PERSONNEL CARRIER



M-13 2-BARREL MAXSON



M-16 4-BARREL MAXSON



T-19 105MM. HOWITZER



M-3A-1 75-MM. GUN



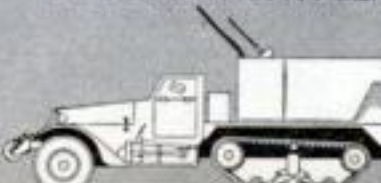
M-4 81-MM. MORTAR



T-30 75-MM. HOWITZER



M-31 81-MM. MORTAR



M-12 155-MM 3 EOC



TANK RETRIEVER

Damaged land battleships are salvaged by this unit consisting of a crane mounted on the turret of a light tank. A larger tank recovery unit is seen on the opposite page

105-mm. howitzer could be fired almost straight up through the trees, giving us fire superiority.

The Alaskan Defense Command has praised this weapon, too, in this report: "The 105-millimeter howitzer, despite almost 'round-the-clock firing in wet weather, with no time for usual maintenance except an occasional bore swab, functioned without difficulty and maintained its long-range accuracy. Nearly 8,000 rounds were fired by two batteries during a 24-hour period. The long range and accuracy of the 105 made it possible to give continued support to the infantry without moving from original positions . . ."

In Africa, a captured German officer asked permission to see our "belt-fed 105." It has no belt feed, but its performance had given him that impression.

A German 105-mm. howitzer was one of the first important pieces of the foe's artillery to be captured and tested thoroughly at Aberdeen. It is in no way superior, and in some characteristics it is inferior to ours. It is neither so rapid nor so accurate as our new howitzer, and would be wrecked if hauled cross-country at the high speeds employed with American artillery.

A weapon's characteristics depend partly on its carriage. Our 105-mm. howitzer was put on a self-equalizing carriage which readily provides a level support for the barrel regardless of unevenness of the ground. Leveling the German howitzer's carriage is like making a four-legged table rest evenly; with ours, it is as simple as setting up a photographer's tripod.

The German 88-mm. gun that got a tremendous build-up in the newspapers during the African campaign has likewise been found inferior in some respects to our 90-mm. gun. The 88 was an anti-aircraft weapon that the Germans turned against tanks and supplied with armor-piercing ammunition. All of our anti-aircraft and field-ar-

tillery weapons can also be directed against tanks. And for every important gun, we have both high-explosive and armor-piercing shells.

We have the further advantage of a standard fuse contour. The fuse determines whether a shell explodes above the ground, on the ground, or after penetrating into the ground. The last is especially important just now. Our standard contour permits different types of fuses to be put on each size of shell without upsetting the range-table data. The United States is the only country that has adopted a contour that makes fuses so readily interchangeable, and no other country can copy this improvement in ammunition in time for this war.

In tanks, as in artillery and ammunition, our Ordnance Department not only has kept up with the Germans, but has insisted on being ahead of them. The medium tank that was developed before 1939 was not put into production in this country. Instead, time was taken to redesign it, and we came out with the M-3, or General Grant, carrying a 75-mm. gun. Within a year this was followed by another model, the M-4, or General Sherman, and the superiority of American tanks over those used in the dreaded German blitz attacks was established at El Alamein.

First in Tunisia, and more recently in Italy, the Germans used their 60-ton "Tiger" tanks. American officers were surprised that they brought this giant into the arena so soon. The explanation may be that they realized that their lighter tanks had been outclassed and feared that we would use our heavy 60-ton tank against them in Africa. We were a year ahead of them in the development of a heavy tank.

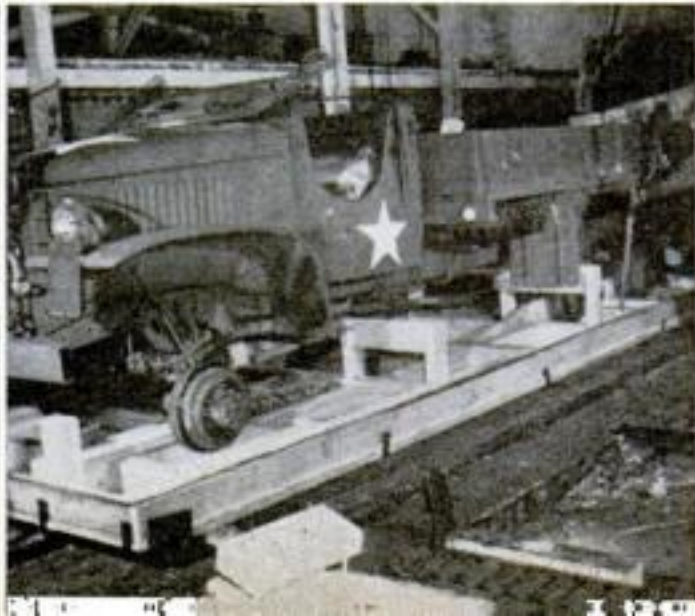
But who has the biggest tanks is not so important as who has the most tanks. There is, perhaps, a tendency on the part of laymen to think that the construction of a new tank such as the German "Tiger" makes

PACKAGING. In an amazing assembly line in reverse, huge trucks are boxed up for shipment overseas. At one end, a vehicle rolls in under its own power . . .

As it moves along, it is washed, spray-painted, and dried in a tunnel of heat lamps. Then workers swarm over it to inspect it and remove superstructure and other parts preparatory to boxing

As the wheels are taken off, the body is placed on a wooden platform that will be the bottom of the crate. This rests on a conveyor that carries it along . . .

Photos by William W. Morris at Chester Tank Depot



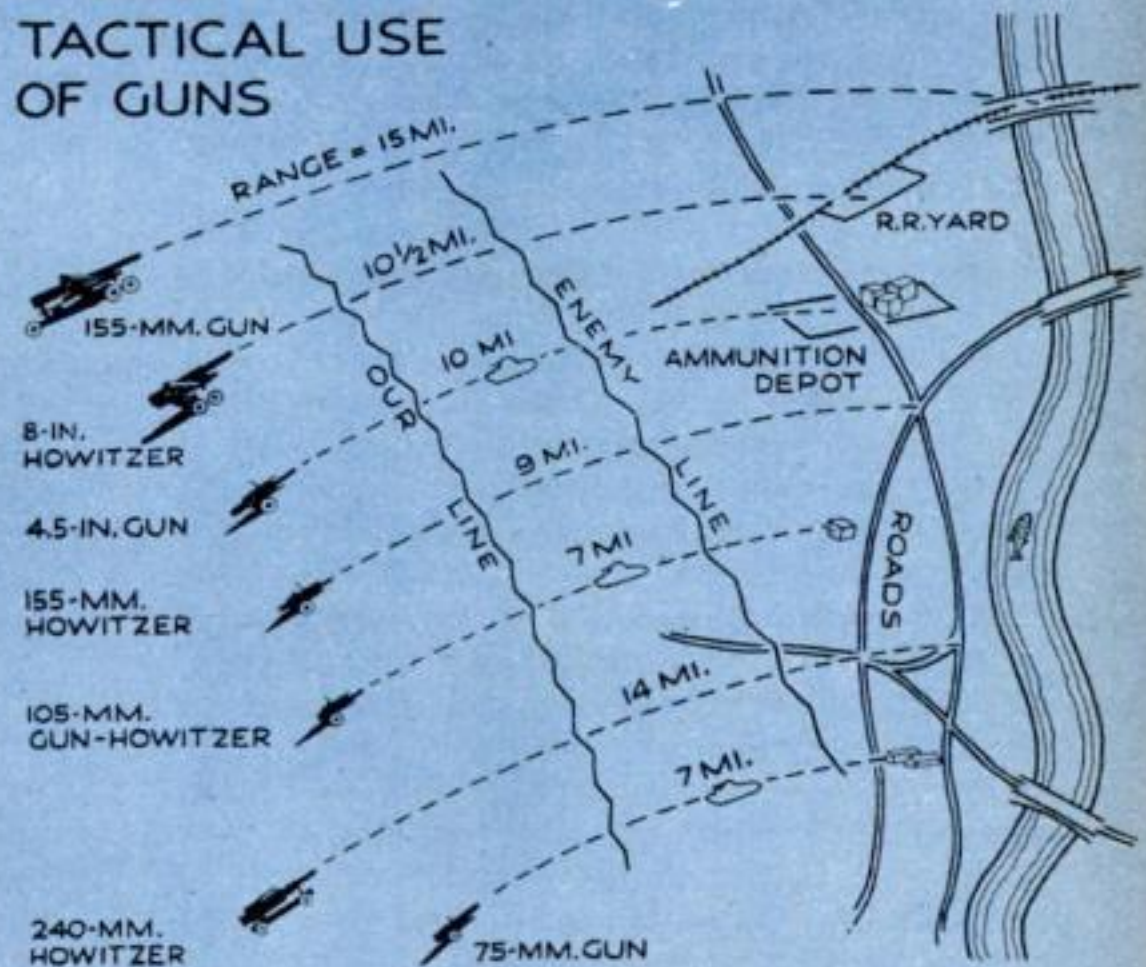
RIGHT ARM OF THE ARTILLERY—THE 4.5 GUN

A HEAVYWEIGHT slugger that can heave a 55-pound high-explosive shell 10 miles and then roll off at 30 miles an hour to smash enemy tanks with blasts of flat-trajectory, short-range fire—that is the mobile and versatile 4½-inch walloper now in use by the Army on European fronts. The gun is mounted on a single-axle, two-wheel carriage and usually is hauled by an M-5 high-speed tractor. With a carriage that permits 65-degree elevation and 120-degree traverse, the gun can belch out its big shells at the rate of one a minute. The weight of the piece is a little over six tons.



Ready for action, the 4.5 pokes its tapered barrel out from under a camouflage net. The drawing below shows how it fits into the pattern of field-artillery support in a battle zone

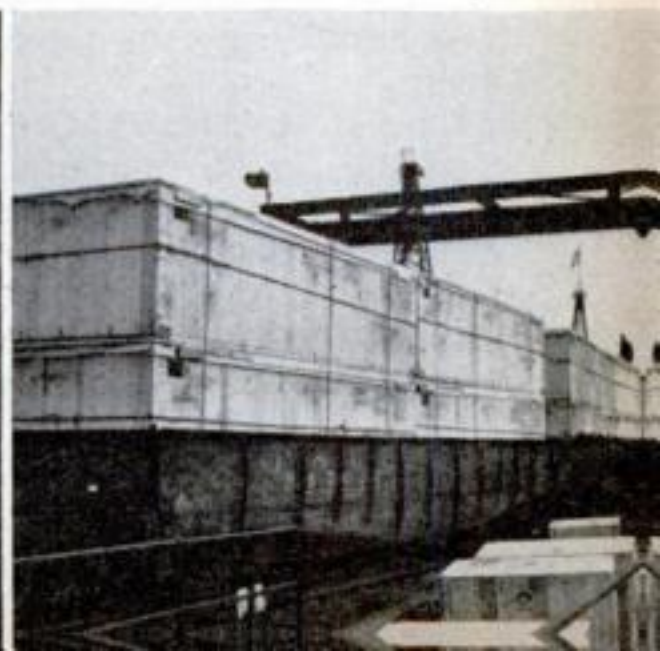
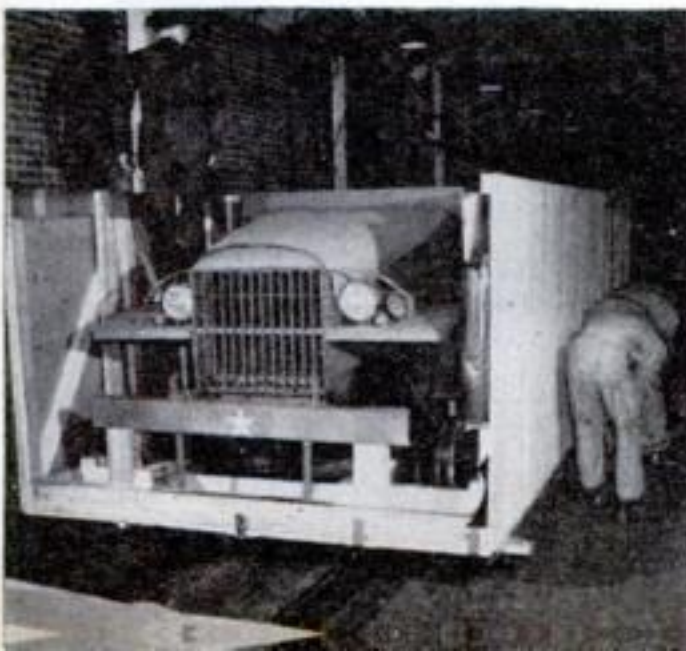
TACTICAL USE OF GUNS



Sides and ends of the box, prefabricated in another part of the depot, are delivered by other conveyors and nailed into place by men who hammer as they walk

Inside the crate goes everything that will be needed to put the truck into immediate operation—detached parts, tools, instruction manuals. Stenciled legends describe the contents fully

Only a few minutes after it entered the line, the truck comes out completely boxed. A mammoth crane lifts it onto a rail car, bound for the embarkation port



lighter models obsolete. Tank warfare, however, calls for several types, and heavy tanks merely supplement, rather than displace, the lighter models.

The tank is a weapon of opportunity, highly useful to a skilled commander with trained troops, but from now on the tanks of all armies are going to have an increasingly difficult time. Antitank guns are becoming more powerful and more numerous on the battlefields. Our 105-mm. howitzer and larger types of artillery are all designed for knocking out tanks. Our 75-mm. aircraft gun enables a plane to stop a tank. Our anti-aircraft artillery can do it, too; and a bazooka can blow a hole through the hull of a "Tiger" and set it on fire. This has been done repeatedly in combat.

The bazooka equips foot soldiers with the equivalent of an artillery piece. It was designed for use against tanks, but it has been put to other uses already. A bazooka will rip off a couple of sandbags and kill the men in a machine-gun nest, or send a projectile ricocheting around inside a sturdy building with deadly effect. It has proved highly useful against Japanese bunkers.

Half-tracks as well as tanks gave the Germans their mobility. They have used half-tracks more extensively than any other nation. The German half-track is really a three-quarter-track, which is not readily stopped by ground interference between the front wheels and the tracks. Our answer to this development has been full-track tractors.

New American high-speed, full-track prime movers, weighing 13, 18, and 38 tons, have all the advantages of big trucks, plus that of being able to go where the trucks can't. They are excellent climbers, and have proved to be very effective haulers of medium and heavy artillery over mountains, through swamps and sand, and over narrow, unbridged trenches and shell holes.

Our mobility has amazed both the Germans and the Japanese. We can execute hit-and-run attacks with our 105-mm. howitzer and even more powerful weapons. "Long Tom," our famous 155-mm. gun, was run across miles of exposed territory in the African campaign, used to smash up a distant airport, and then run back before daylight. Two days after the Marines landed on Rendova Island, a row of "Long Toms" was hammering the Japs at Munda, 11 miles away.

The U. S. Army's Ordnance Department was the first to manufacture self-propelled artillery, and has retained leadership in this field. We have built thousands of self-propelled weapons since 1939. When examined closely, the Germans' self-propelled artillery turns out to *(Continued on page 206)*

THE 4.2 mortar, nicknamed the "goon gun," is a Cinderella among American weapons. Developed by the Chemical Warfare Service to hurl gas, it has blossomed out as a light and versatile adjunct to the artillery. It routs the enemy with stinging white phosphorous, blinds him with smoke, and pelts him with high explosives.

It is only 3½ feet high and weighs only 300 pounds. Easily hauled by jeep or moved by hand, it can be taken over the roughest terrain, hidden in a gully, and fired so rapidly that the Nazis mistook it at first for an automatic cannon.

It can lob a 24-pound projectile 2½ miles in 60 seconds. Although it is loaded by dropping shells down its muzzle, a crack crew can fire seven shells before the first one has landed. Its rifled barrel (P.S.M., Dec. '41, p. 113) makes it so accurate that a mortar unit in Italy actually dropped a round of high explosive into a German tank's open turret. And a dozen shots from this ugly duckling sufficed to knock out a battery of German 88-mm. guns weighing 30 times as much as it does.

The "goon gun" hurls nearly twice as much white phosphorous as an 81-mm. infantry mortar and throws it 1,500 yards farther. Its range with high-explosive shells is from 20 to 100 percent greater than the maximum attained by 60- and 81-mm. infantry mortars with lighter shells. Its mobility, punch, and versatility have made it one of our men's favorite weapons.

Photos by William W. Morris

The projectile is dropped into the business end of the "goon gun." When it hits the bottom of the barrel, impact fires the cartridge



CHEMICAL WEAPON TURNS GUN-OF-ALL-WORK

Below are a high-explosive shell (left) and smoke shell. Markings on the case tell the nature of the charge. Rings in the noses are safety pins, which are pulled in loading



The mortar in action, with projectiles piled behind it. As soon as it is set up, it can start delivering five rounds per minute with the accuracy of an artillery piece at ranges of 600 to more than 4,000 yards. The projectiles weigh about 24 pounds apiece



This is a motorized chemical squad. The first jeep carries the leader and three men, with the mortar and eight rounds of ammunition in a 1/4-ton trailer

The jeeps can go almost anywhere that troops can operate. When unloaded, they shuttle back and forth to bring up additional ammunition

The second jeep carries two men and 16 rounds of ammunition—eight on the floor and four on each side. Its trailer holds another two dozen rounds

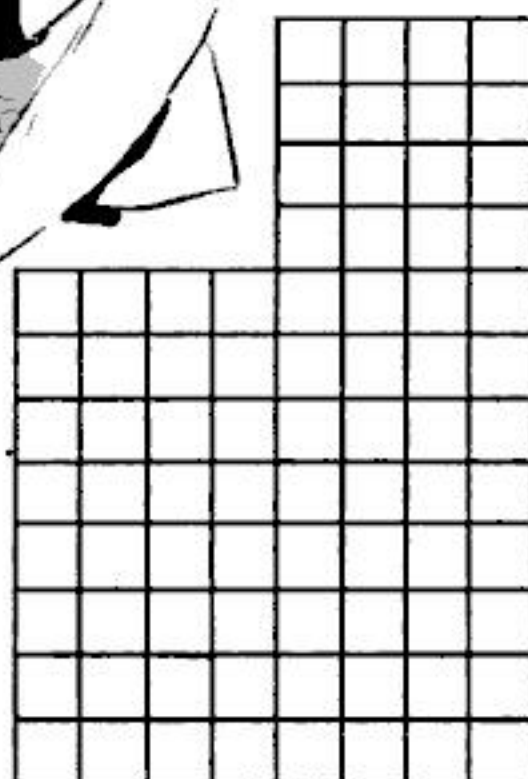
Sandbags hold the mortar down for rough riding. In action, they are packed around the base. The complete mortar weighs 300 pounds





Can You Solve These Teasers?

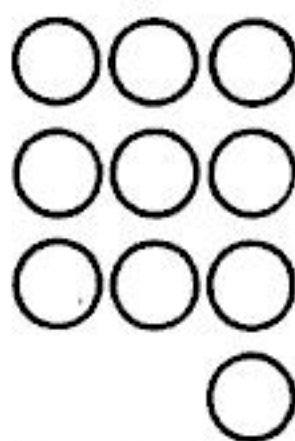
1 Thrifty Grandma purchased a piece of cloth of the shape and pattern shown. By cutting it into only three pieces and then sewing the pieces together, she made it into a square bedspread of the same pattern. No cloth was wasted. Can you show how she did it?



AUTHOR of these problems is Dr. Harry Langman, a "tease-master" who has made a hobby of puzzlers. He is a New York mathematician and also the author of a forthcoming puzzle book. Solutions—and in some cases, incidentally, there is more than one correct answer—will be found on page 210.

1 2 3 4 5 6 7 8 9 0

HERE are a couple of teasers that use all of the above digits, yet use each digit only once. These puzzlers are simply problems in addition and multiplication—but in reverse. In each case you start with the answer and then try to see how you got it.

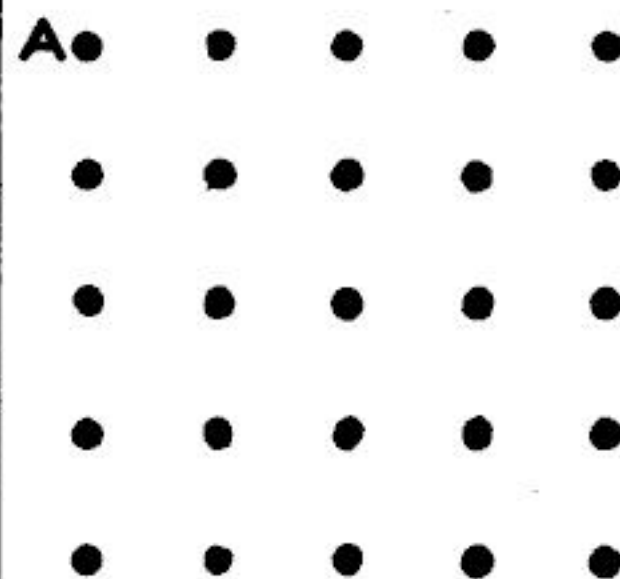


1944

2a The trick is to place the digits in the circles so that they will add up to the sum of 1944. Remember—you can use each of the digits only once.

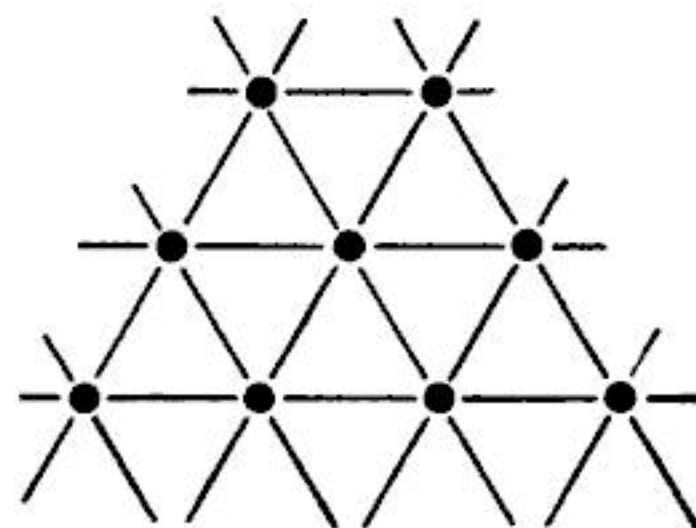
2b Here the idea is to fill the circles with the digits so that after completing the indicated multiplication you will have three products that give 1944 as the sum.

$$\begin{array}{r}
 \bigcirc \bigcirc \bigcirc \times \bigcirc = \text{---} \\
 \bigcirc \bigcirc \times \bigcirc = \text{---} \\
 \bigcirc \bigcirc \times \bigcirc = \text{---} \\
 \hline
 1944
 \end{array}$$



3 If a man starts out from A in a car, what course will enable him to touch each of the other 24 evenly spaced points and return to his position at A with the least consumption of gas?

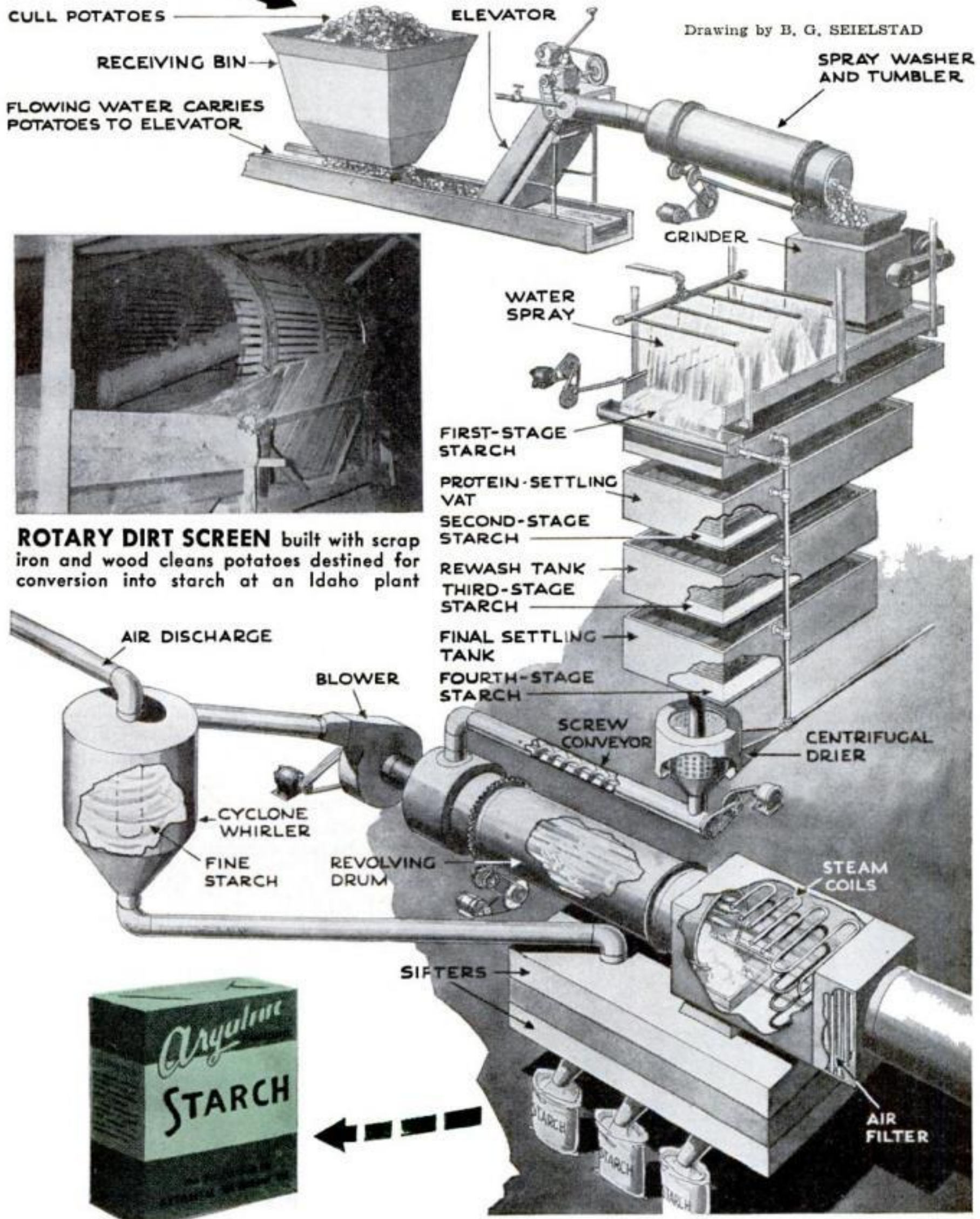
4 Following the design below, an architect plans to use on a ceiling a certain number of rods (lines) and tacks (dots). If he orders 60,000 rods, about how many tacks will he need to hold down both ends of all the rods? Only an approximate figure is required.





Starch from Spuds

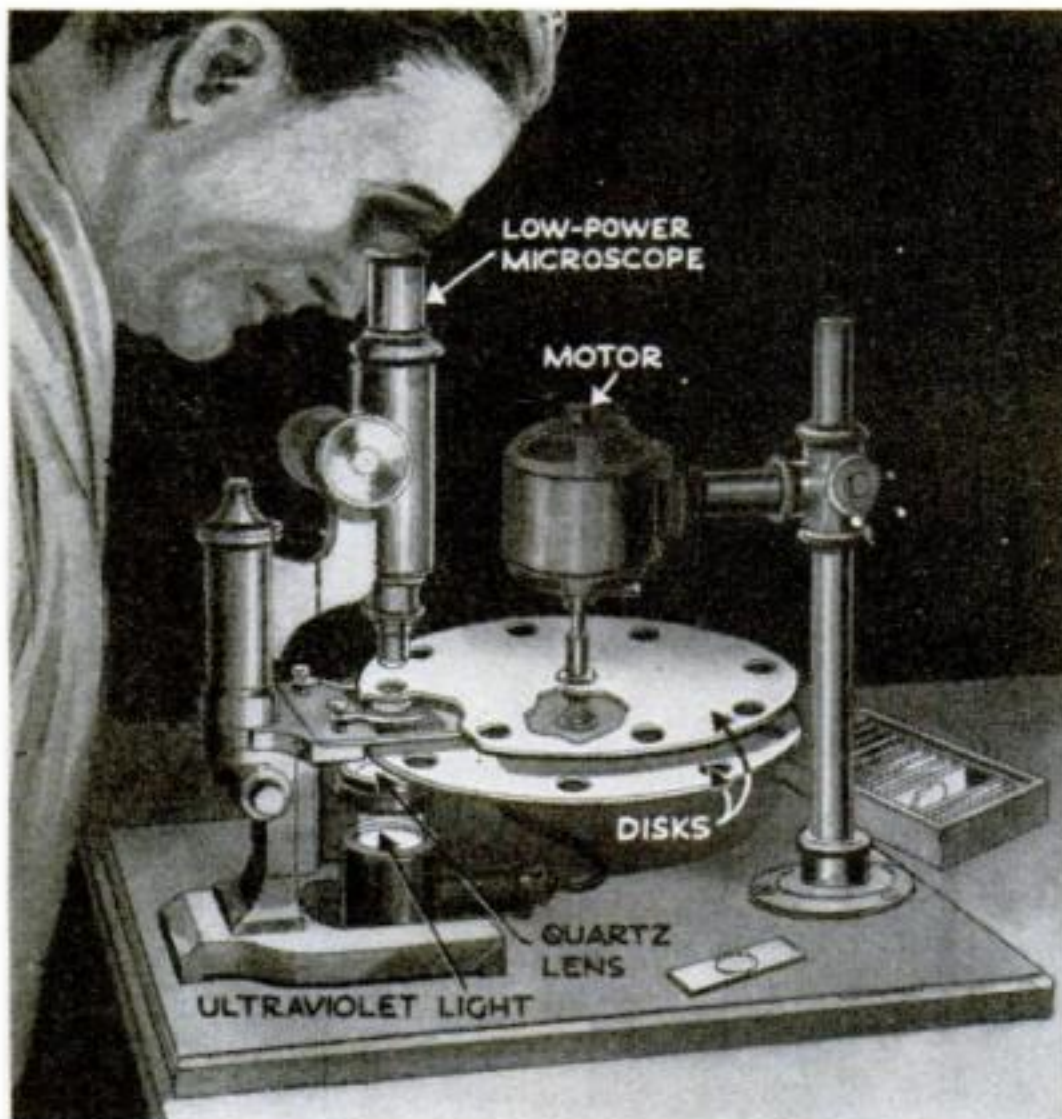
FORMERLY wasted, cull potatoes are now being turned into starch at three busy plants in Idaho. The machinery was assembled by a group of ingenious farmers, doctors, and lawyers, with expert assistance from the National Farm Chemurgic Council and the Idaho Power Company. Hampered by wartime shortages and priorities, the builders resorted to makeshift materials and equipment. When their order for girders was rejected, they bought an abandoned bridge and welded its steel into supports. Automobile transmissions and other machinery were retrieved from junk yards, reconditioned, and adapted to use.





MEDICAL MASKS are one more addition to the ever-lengthening list of uses to which paper, treated for wet-strength, is now being put. Given a simple treatment, the paper remains comparatively unaffected by moisture, retaining at least 40 percent of its original strength even when thoroughly soaked. Lighter, and a good deal cooler, than the cloth masks usually used in medical work, the paper masks can be boiled for sterilization and then hung up to dry for re-use. Similar masks are used to protect factory workers from toxic dust.

NUTTY SNOWFLAKE. Looking like a hexagonal glass nut, this snowflake recently fell from the sky during a snow-storm in Schenectady, N. Y., and was photographed by Vincent J. Schaefer, of the General Electric Research Laboratory. Looking at least an inch wide in this remarkable photomicrograph, the hole in the center of the flake actually is only four times the size of an ordinary hair. The flake itself was only about one twentieth the usual size.



NEW FIELDS of research in biology and mineralogy may be opened up by a "phosphorescence microscope" devised by Dr. E. N. Harvey and Dr. A. M. Chase, of Princeton University. It has long been known that certain fluorescent substances continue to glow, sometimes for only a fraction of a second, after being exposed to ultraviolet light. Because of the shortness of these periods of glowing, microscopic examination of this phenomenon has hitherto been impossible. By means of two revolving disks with staggered openings, the ultraviolet light—while being kept from entering the microscope—illuminates the object in a series of flashes following each other so closely that the object appears to glow without interruption. The perforated disks are used in combination with a standard microscope.

What Are We Doing with Jap and Nazi Property?

BANKS, BUSTS, AND BABY SHOES ARE DUMPED IN CUSTODIAN'S LAP

TWO men sat at a velvet-covered table rolling tiny little white balls back and forth. They watched intently as the pellets rolled. Now and then they picked up one to look closely at it; then they went on rolling them back and forth.

No game of marbles this, as you could tell by the seriousness of the two men. A gambling game? Yes, in a way, it was. They were appraising 10,800 pearls seized from a Japanese outfit by the Alien Property Custodian. It seems you get a better idea of a pearl's quality and beauty when it is rolling on black velvet. For four solid days these two men sat at their odd-looking game, and then they put in a sealed bid of \$50,000 for the lot. They won, all right, for the next-highest bidder played his odds too long and offered only \$28,000. The winners were happy over their purchase.

This sackful of fine pearls was just one item in the fabulous list of properties Custodian Leo T. Crowley found on his hands when he moved in to take charge of all property belonging to enemy nationals. We did not go to war for booty, but we came by enough of it for several kings' ransoms. It takes in just about everything you could think of, from shoestrings to steamships, from a delicatessen to a bomb factory. There are personal belongings of rich and poor, going concerns of many kinds, banks, insurance companies, and real estate, as



RARE ART TREASURES are among the confiscated effects of enemy nationals. This ancient Chinese ceremonial pouring vessel, for example, was a part of the stock of a Japanese art-importing firm that was taken over by the Custodian after Pearl Harbor



CEREMONIAL SWORDS are fancied by the Japs—a snickersnee for practically every social occasion. The longest of the three shown is a standard beheading sword, and the shortest is considered *de rigueur* for hara-kiri, or, as the Japs call this form of self-immolation, seppuku. These examples were among several that were in personal effects left behind by a Nip

well as objects of art of inestimable value.

The Custodian and his staff of more than 1,000 Federal employees have been busy for months trying to turn it all into one common denominator—cash. It is sold to American citizens only. Many bargains have been picked up, as always happens under a liquidation, and there are still many more. Everything is appraised before these sales, however, and bids are rejected if they are too low. If the original owners get back anything at all after the war, it will be cash, not the property.

The Custodian's liquidators took over the Yamanaka store on Fifth Avenue, New York, with one of the finest collections of Oriental art in the world. They would have been happy to find a buyer for the whole stock and be done with it, but it was worth millions and no customer for such a vast lot of luxury items was in sight. So they kept the store going and went to work selling ancient bronze and pewter dating back before Christ, intricately carved jade, teakwood tables, porcelain, hand-wrought objects of every description, mostly produced by Chinese artists. The Japanese owners had all the items price-tagged, but the prices were marked down to make the goods move. Some bargains have been picked up, though selling prices have been as high as \$25,000 on a single object of art. After considerably more than half of the stock had been disposed of in this manner, the remainder was placed on public auction for speedy liquidation.

The Custodian's people have found buyers for such items as an Egyptian mummy, a Japanese beheading sword, and a hara-kiri dagger. Among the office equipment of one German propaganda outfit there was an excellent bronze bust of Hitler. The Custodian decided against selling this, but made a gift of it to the U. S. Treasury. It was busted up by Boy Scouts as part of a bond-selling campaign in Brooklyn.

Twice the Federal officials have inherited dogs. One couple who operated a delicatessen in New York were arrested by the FBI. The store was padlocked, and when the Custodian's employees went there to take over, they found a little dog in the back of the place. Here was a new legal problem: what to do with a dog until the property could be disposed of as prescribed by law. It was solved by turning the dog over to the SPCA. The precedent thus established was followed later in the case of a bird dog and a parrot.

Then there was the case of the baby's shoes. Sorting out a lot of personal things in preparation for a sale, officers came across a package tucked away in the corner of a trunk. It contained a pathetic little



RARE CHINESE IDOL, made of wood and close to 1,000 years old, has been taken in along with other alien art. The figure is a bodhisattva, or Buddhist divinity, dating from the Sung dynasty. Heroic in size, it was intended for a high pedestal

pair of baby's moccasins, scuffed and battered, but carefully wrapped in tissue paper. This was one item that was missing from the official list of goods offered for sale that day. The baby's shoes were taken out, after due consideration of the case, and stored away with the mother's name on the package to await the end of the war.

The Custodian put on quite a bargain sale in a big New York warehouse in March, disposing of the personal belongings and household goods left behind in July 1941 by Ernst Schmitz, formerly head of the German Railways Information office in New York, and by his four associates in this Nazi propaganda outfit. Schmitz evidently had lived high. He had expensive stuff of all kinds—eighteenth-century furniture from Germany, Oriental rugs, silverware in abundance, fine china, oil paintings, an extensive collection of antique pistols and daggers, and sporting equipment of almost endless variety.

The Custodian has taken over 13 banks and six insurance companies, and these are being liquidated. Under the law, the Custodian assumes ownership of all stock in American corporations held by enemy nationals. In cases where this is a majority, he becomes the controlling owner. His duty is to sell the stock to Americans, and this is being done. *(Continued on page 195)*

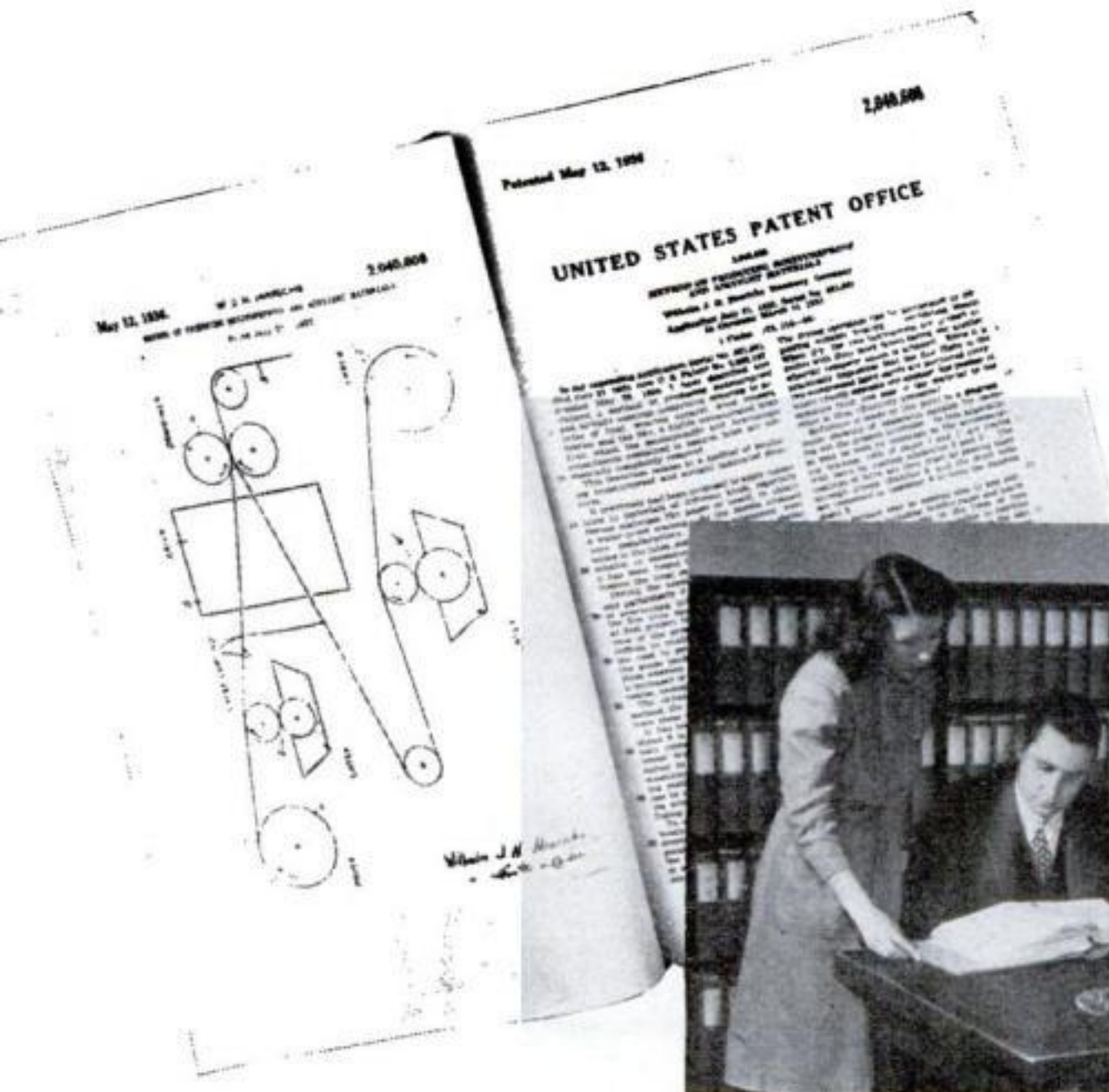


NINE-FOOT CLOCK and two other eighteenth-century pieces of fine furniture were among the effects of Ernst Schmitz, former head of the German Railways Information office in New York and active pre-Pearl Harbor propagandist for the Nazi régime

PRECIOUS CELLO, made in the 15th century by Francesco Ruggieri, was appraised by an expert at \$2,500 but a musician was able to buy it for \$1,500. Whenever bids are unreasonably low, they are rejected



AMERICANS MAY USE SEIZED PATENTS FOR \$15 EACH



THE ENEMY HELPS us to beat him. Americans have access to 45,000 patents owned by enemy nationals or those of occupied countries. A public library in each of five cities contains the patent papers, and there are helpful librarians in charge. Patrons are mostly manufacturers looking for possible new products or ideas for improvement of their lines. Radiant energy leads all subjects among these patents



WHAT'S AHEAD IN

AN EXPERT TELLS YOU WHAT—AND WHAT NOT—TO EXPECT

By CARL DREHER

YOU'RE on hazardous ground when you begin to predict anything about the postwar era. But one thing you do know for certain: it's going to be The Age of Electronics.

"Oh, yes," you say, "I've seen a lot on that subject, and much of it was visionary hokum." You're right. Some aspects have been overemphasized. Yet the fact remains that you can hardly name a phase of daily living which will not be affected. So vast is the field, so important its bearing on your life tomorrow, that we have arranged for a series of articles by an electronics engineer and writer who grew up with the subject. This month's article on communications will be followed by articles in the August, September, and October issues covering every prospective major development in postwar electronics.

Don't miss one of these. Since we're limited by the paper shortage in the number of copies we can print, ask your newsdealer to reserve these issues for you.

ELECTRONICS is not an industry in itself, any more than chemistry or physics. It is a technique, a way of doing things in a lot of industries. It did, however, create one industry—radio—and the requirements of that industry resulted in the invention of the vacuum tube. From that point electronics spread out until now we use it not only for transmitting light and sound through space, but for controlling power, motion, temperature, quantity, and quality; measuring, magnifying, positioning, detecting, checking, sorting, grading, and analyzing. That takes in a lot of ground, but it still leaves communications as the principal outlet of electronic ideas and devices for the present and for some time after the war.

Communications have always been tied up closely with transportation. Electronics has vastly broadened the possible services of communications in the transportation field, especially in reducing its hazards. With increasing sizes, weights, speeds, and numbers of ground vehicles, ships, and aircraft, systematic collision prevention will become ever more important after the war, especially in aviation. A normal pair of eyes and ears usually will enable a man on foot to avoid bumping into other pedestrians or being knocked down by automobiles. But when you cover



The magic of electronics lies in our vacuum tubes. They amplify, generate, control, transform, or convert electrical energy in countless incredible ways. The one at left is a short-wave power tube in a Westinghouse station. There are much bigger ones... like those that work in steel mills; and much smaller ones... like those in the instrument that measures the currents of a human brain

ELECTRONICS?

FROM THE VACUUM TUBE IN THE FIELD OF COMMUNICATIONS

a mile in eight or 10 seconds you have to know what is ahead for a distance considerably greater than you can see under some conditions. Just as a partially deaf man needs a hearing aid, and a man with defective eyesight needs glasses, men with normal vision and hearing, piloting modern airplanes, need electronic sensory aids.

The operation of these devices is based on reflection of ultrahigh-frequency radio waves from objects. You send out a beam of such waves and some of it—a barely perceptible fraction—comes back and you know another airplane or a mountain or factory chimney or radio tower is up ahead. The advantage of this method is that it is independent of the vagaries of visible-light transmission through the atmosphere. It enables us to see, or at least to sense, objects in the darkness, or through smoke, fog, or clouds.

Research along these lines dates back to the early 1930's, when it first became possible to play with waves in the centimeter region. The absolute altimeter, introduced in 1938, was one practical result. Microwaves transmitted downward from an airplane and reflected back would tell the distance of the airplane above the ground—something of even more interest to the pilot than his altitude above sea level, which an ordinary barometric altimeter would give him. Turn

the beam horizontally or at an angle and you have an obstacle detector.

Electronic equipment of this type will be widely used for collision prevention after the war. It would be a mistake, however, to regard it solely as a necessity forced on us by speed. Low-speed transportation likewise needs electronic safety devices. A 5,000-ton freighter groping at eight knots through a fog is a menace to itself and other shipping. A train crashing into another train at 40 or 50 m.p.h. can kill more people than a dozen airplane wrecks. In some of these cases we do not have to resort to reflection of microwaves; ordinary radio communication on longer waves will suffice to avert disaster. By all the evidence, direct radio communication with the locomotive cab would have prevented the

Here are tubes that you will never find in your radio. Included are the ignitron, pliotron, kenotron, thyatron, phanotron, and the phototube. All are made by General Electric and are used in various types of industrial electrical equipment



loss of 80 lives in the Congressional Limited wreck last year. The Tamiami wreck in North Carolina was an even more striking example. In this instance a southbound train was derailed, with slight damage, at night. Three cars heeled over onto the northbound track. The fireman of the disabled train went forward with a fusee, or signal flare, and a red lantern. He fell and broke the fusee. The engineer of the oncoming northbound train failed to see the red lantern. Over 70 people were killed.

The point is that the second train could have been prevented from coming anywhere near the first train, for when the initial derailment occurred the oncoming train was 40 minutes, and probably more than 40 miles, away from the scene. Primitive signaling devices such as fusees and lanterns, or even advanced electromechanical safety devices such as block systems, should be no more than auxiliaries to radio in collision prevention. After the war, no doubt, limited trains, like commercial airplanes, will be equipped with radiotelephone equipment for continuous communication. The telegraph wires paralleling the track may be used as high-frequency carriers, so that the actual radio link will be only a few

yards long and it will be possible for messages to ride over a high noise level with moderate amounts of power.

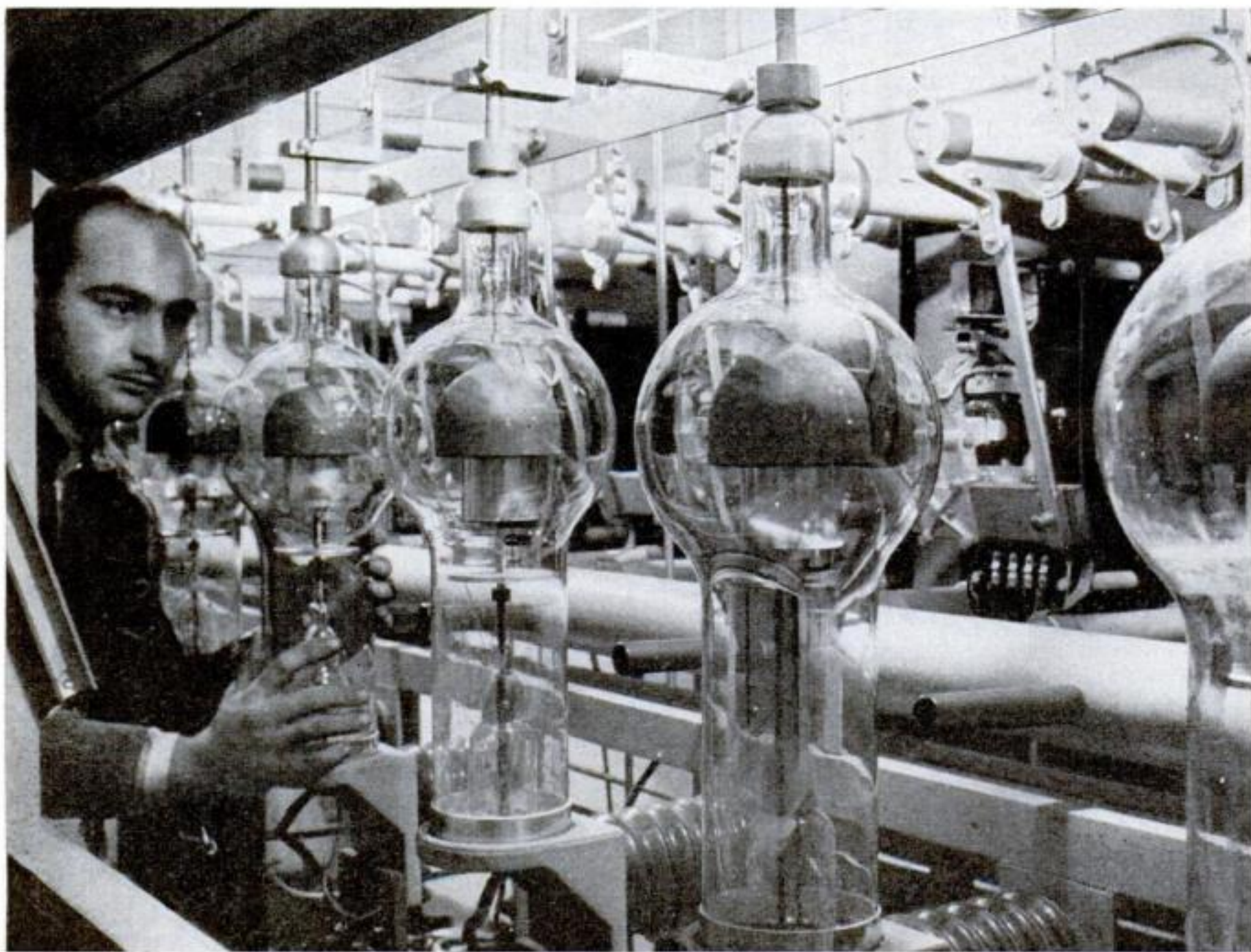
The likely sequence of postwar electronic safety applications in transportation is as follows:

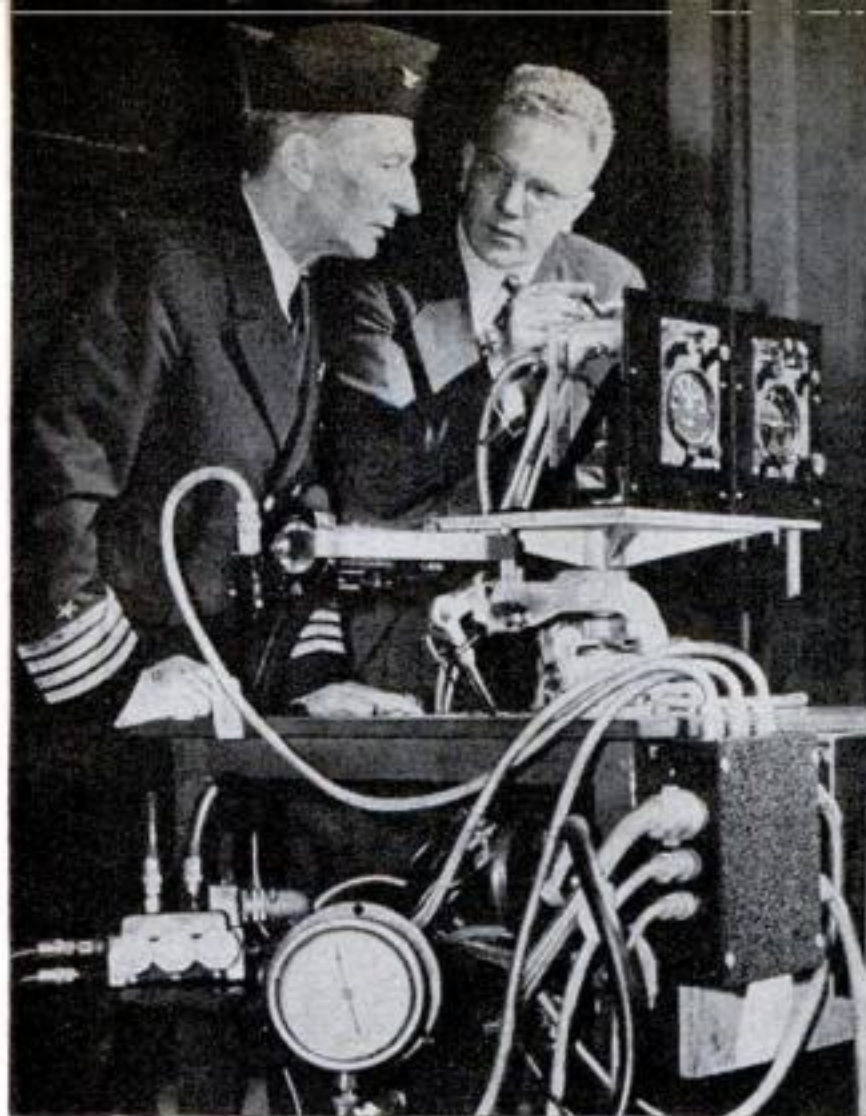
1. *Installation of obstacle detectors on all commercial airplanes.* This may be expected to start immediately after the war. Before long, regulations will prohibit a commercial airplane from taking off unless both its collision-prevention and radio-communication equipment are in good working order. There will be extensive use of high-frequency radio beams or ranges, markers, and runway indicators, with the ultimate aim of making safe landings possible in any kind of weather.

2. *Installation of obstacle detectors on seagoing vessels.* Electronic navigational aids (radio direction finders) and depth sounding (the latter is essentially an electronic technique although it uses sound waves in water) will also be more widely used in the shipping industry after the war.

3. *Equipment of trains with radiotelephones.* At the end of 1943 the railroads asked the Radio Technical Planning Board to undertake an immediate examination of

These Westinghouse high-voltage rectifiers change alternating current into direct current for use in radio transmission. A system of relays enables the tubes to be changed without interrupting a broadcast



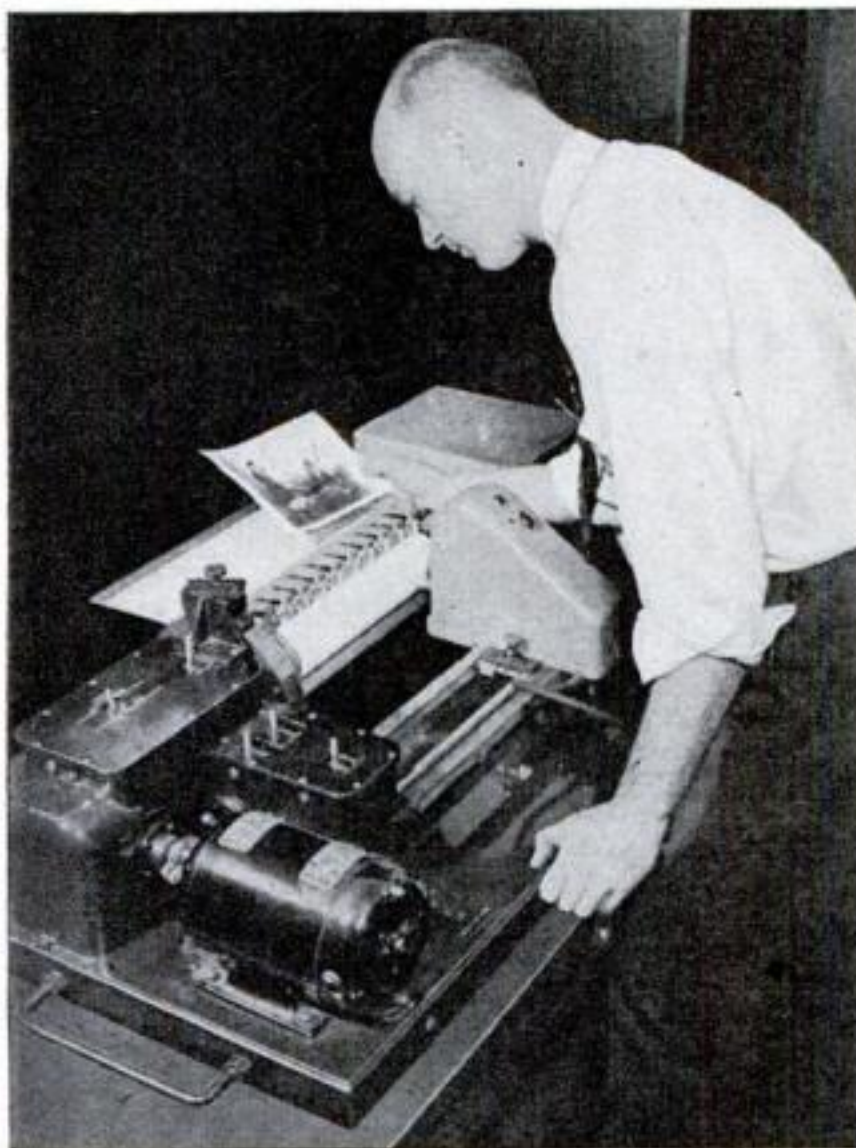


An automatic pilot is carefully examined by Capt. Joseph S. Evans, U.S.N., inspector of naval materials for the General Electric Co. Another electronic device on which aviation will lean heavily is an obstacle detector that will virtually eliminate danger of collision when planes flood the postwar skies

the public-safety possibilities of train radio. After experience has been gained with a few experimental installations, the rate of adoption may be expected to become fairly rapid, especially as radio offers other possible advantages, such as telephone service for passengers.

The above developments will probably take place during the five-year period following the war. Their commercial possibilities should not be exaggerated. If about 10,000 airplanes and 10,000 ships are equipped with obstacle detectors, the initial market will be pretty well saturated. Walter Evans, a vice president of the Westinghouse Electric & Manufacturing Company, recently estimated that equipment of this type for the entire prewar air-transport fleet of the United States (about 400 planes) could have been turned out in just eight days by a single Westinghouse plant now producing radio equipment for the Army and Navy. The postwar air-transport fleet may be three or four times as great, but even if it is 10 times the prewar size—a decidedly optimistic forecast—this one plant could turn out our total requirements in less than three months. Private planes may absorb some equipment, but most private pilots will not go in for flying under conditions that make obstacle detectors an absolute necessity. As for the railroads, even if all the 40,000 or 50,000 locomotives in service should be equipped with two-way radio, which is most unlikely, they would still absorb only a modest fraction of our enormously expanded radio-manufacturing capacity.

If automobiles were generally equipped with obstacle detectors, it would be a dif-



One of the marvels of electronics that will see even wider usage after the war is radiophotography. This RCA receiver in New York can be tuned in on a distant correspondent and in 10 minutes produce a five by seven-inch facsimile of a photograph radioed from the other side of the world

ferent story. Traveling at night or in fog on long, straight stretches of express highway, at speeds between 80 and 100 m.p.h., a motorist could conceivably employ microwaves for obstacle detection to advantage. But why should he drive at such speeds under these conditions? The automobile, unlike the airplane, is not held to a high-minimum forward speed. It can always slow down to whatever speed is safe under



Photo by Westinghouse

existing conditions. The use of electronic devices to encourage driving at high speeds would not promote safety. The situation in that case would be the same as in the past—with roads and brakes unable to keep pace with faster cars, so that the accident rate has continued to rise, or, at best, has remained stationary.

Another proposal of doubtful merit involves an automobile radio receiver which will warn the driver of impending danger by means of low-power automatic transmitters located along the highway. The warnings could be by voice or in the form of visual signals, such as red, green, and yellow lights on the instrument board. An auxiliary device might close the throttle if the motorist attempted to pass through a red light. But, aside from the objection to what some motorists would regard as regimentation, any such mechanism would require a stand-by receiver in continuous operation in every motor car, and these receivers, as well as the roadside transmitters, would have to be maintained in top-notch working order. Reflector signs are much cheaper and more reliable, even if they are not electronic.

Another field of postwar electronic development is that of personal two-way radio. During the first World War, vacuum tubes came into extensive use for radio reception, but transmission was carried on almost exclusively with spark sets operating in what is now the broadcast band, or at higher wave lengths. A portable transmitter-receiver was something to be carried on muleback, and before it could be put in operation an aerial mast of considerable height had to be erected. The source of power was usually a hand-driven generator. Communication was by Morse code.

The equivalent transmitter-receiver in the present war is a small, dry-battery-powered vacuum-tube radio-



Battery-powered fluorescent lights, supported by rubber "doughnuts" developed by Firestone, can be strung out to form lanes that will guide seaplanes in making night landings. Each light has a radio receiver in the base of its mounting. By means of short-wave control from a near-by shore station, the lights can be turned on and off as required



Known as "the pack," the New York Fire Department's version of the Army's "walkie-talkie" is tested by the department's assistant chief, John McCarthy, who has used the radiotelephone to direct his men in fighting a fire. A "phone" also connects his car with fire headquarters

telephone carried on a man's back and using a buggy-whip antenna some five feet long. This is known as a "walkie-talkie." The even more compact "handie-talkie" weighs only a few pounds more than a standard telephone handset. With a pair of these outfits two men can talk over a distance of one or two miles, without knowing a thing about electricity, radio, or telegraphy.

The soldier who has used equipment of this type in front-line reconnaissance or artillery observation will remember it when he gets back to the farm and the tractor breaks down a mile from the house, or when he wants his youngster to bring him that bottle of "coke" from the refrigerator on a broiling-hot day. The present handie-talkie may, in fact, be developed into something that will fill the need for some form of practical short-range radio communication. The problem has been solved as far as talking is concerned; what is needed now is an inexpensive calling system which will not require the receiver to be constantly energized. In some applications, however, such as logging operations, surveying, and fire fighting, the portable transceivers developed for military use may be practical just as they are, and as these undergo further development their field of use will expand. We are likely to have more and more short-range radio communication at a diminishing cost, thereby saving much time and trouble in industrial operations and eventually in daily living.

Unlimited two-way radio communication, whereby anybody will be able to call up anybody else at any time, anywhere, using a gadget no bigger than a hearing aid, is, however, still a long way off in the future.

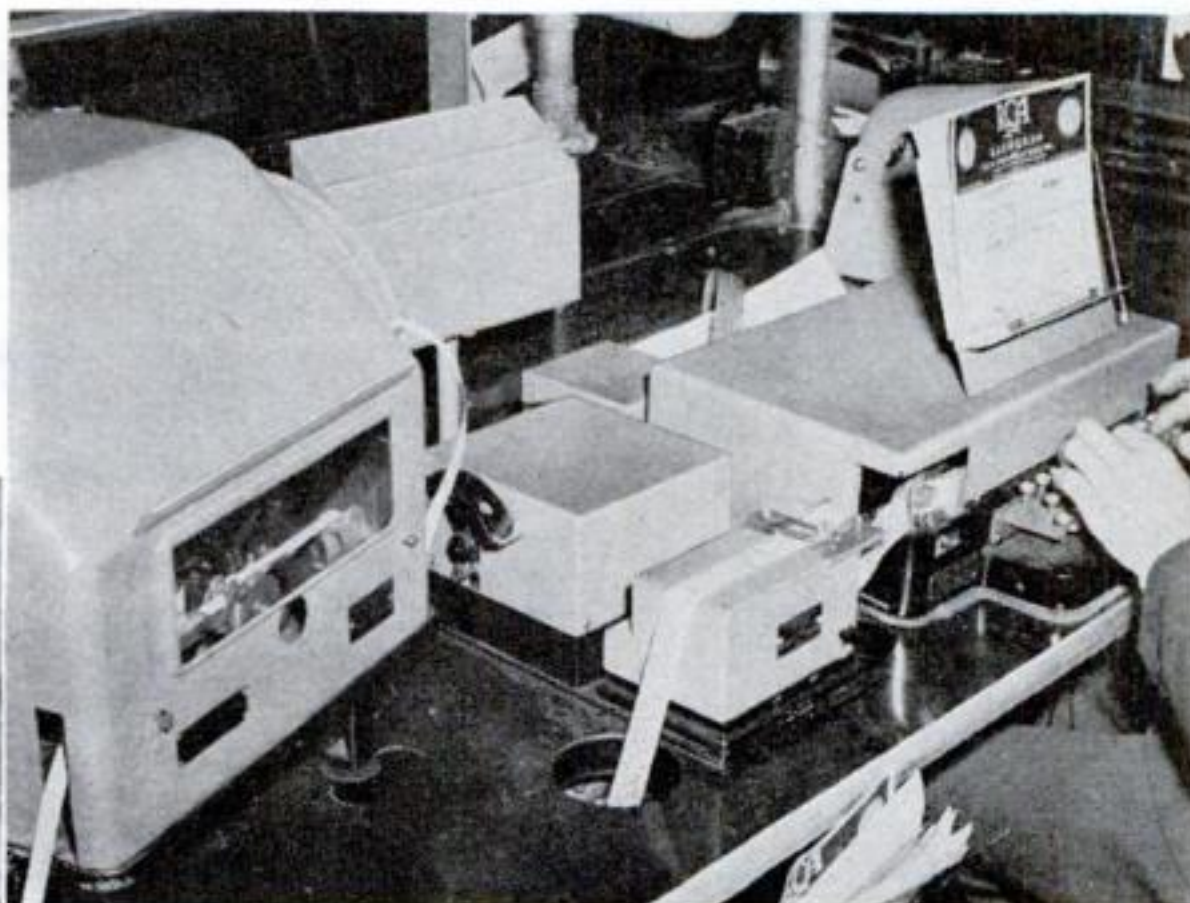
A more promising and largely untouched field for two-way radio communication is on private cars, pleasure boats, and airplanes. Within a comparatively few years after major hostilities end, it may be possible for the motorist to buy or lease equipment which will enable him to keep in touch

with his home, business, and friends through radio-wire telephone exchanges located along the main highways. Technically, the problem of transmitting from vehicles is not too complex, since they are already equipped with adequate power sources. Police cars are now using this technique, and crystal-controlled, frequency-modulated transceivers on tanks, tank destroyers, and field artillery are proving successful under conditions of noise, interference, and vibration which will hardly be encountered in civilian use. Here, then, we have a possible outlet for low-power point-to-point radio communication equipment which may assume substantial proportions.

While there will be far fewer private motorboats and airplanes than automobiles in the first postwar decade, boat and plane operators will have a much more urgent need for two-way radio. In a boat or airplane you can't stop and go into a telephone booth every few miles. Also, the safety angle is much more of a selling point. Here, then, is another electronic market which merits research and development. It is neither new nor uncharted. Beginning in 1932, motorboats in the medium-price class, and larger vessels plying inland and coastal waters, were equipped with AM radio linking them to the wire-telephone network through shore stations. There are now 27 such stations in operation, and before the war there were half a million registered pleasure boats.

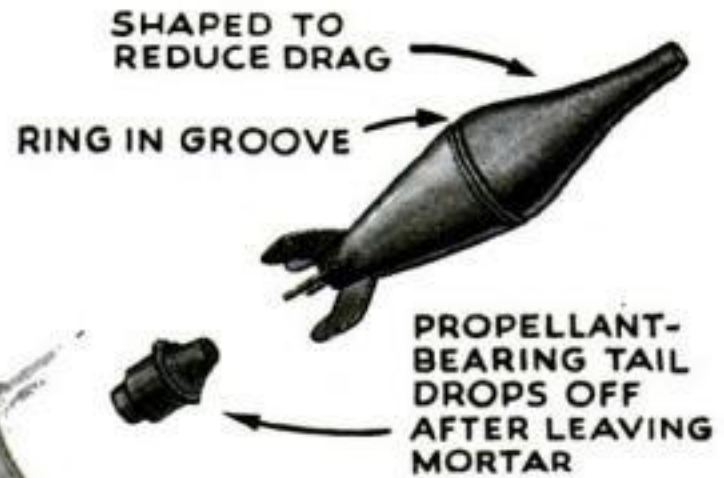
What will be needed after the war are compact, light, reliable, and inexpensive transmitters and receivers, especially designed for these types of service with a minimum number of tubes and adjustments, rather than cut- *(Continued on page 214)*

By using carrier currents of different frequencies, several messages can be dispatched around the world simultaneously on this RCA high-speed multiplex radio-telegraph printer without danger of the messages getting scrambled



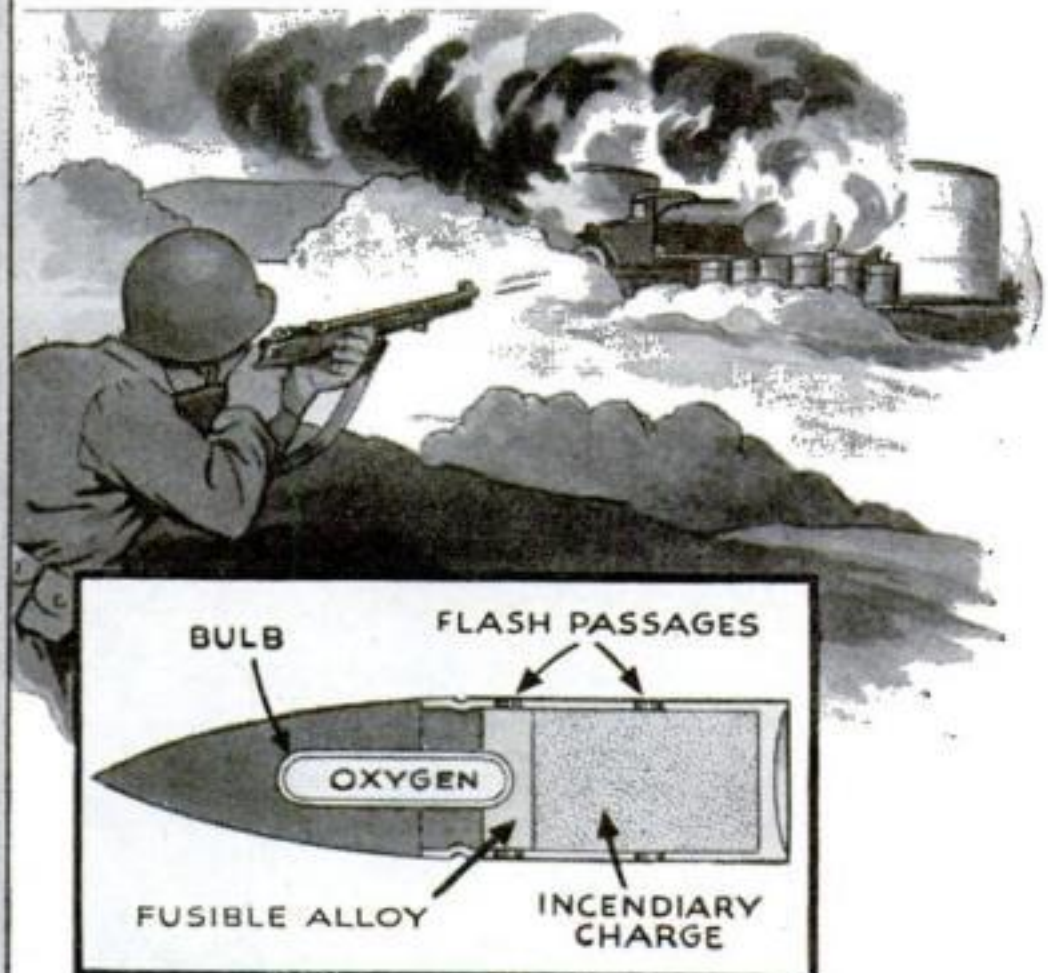
war ideas

Drawings by ABBOTT GRIFFIN



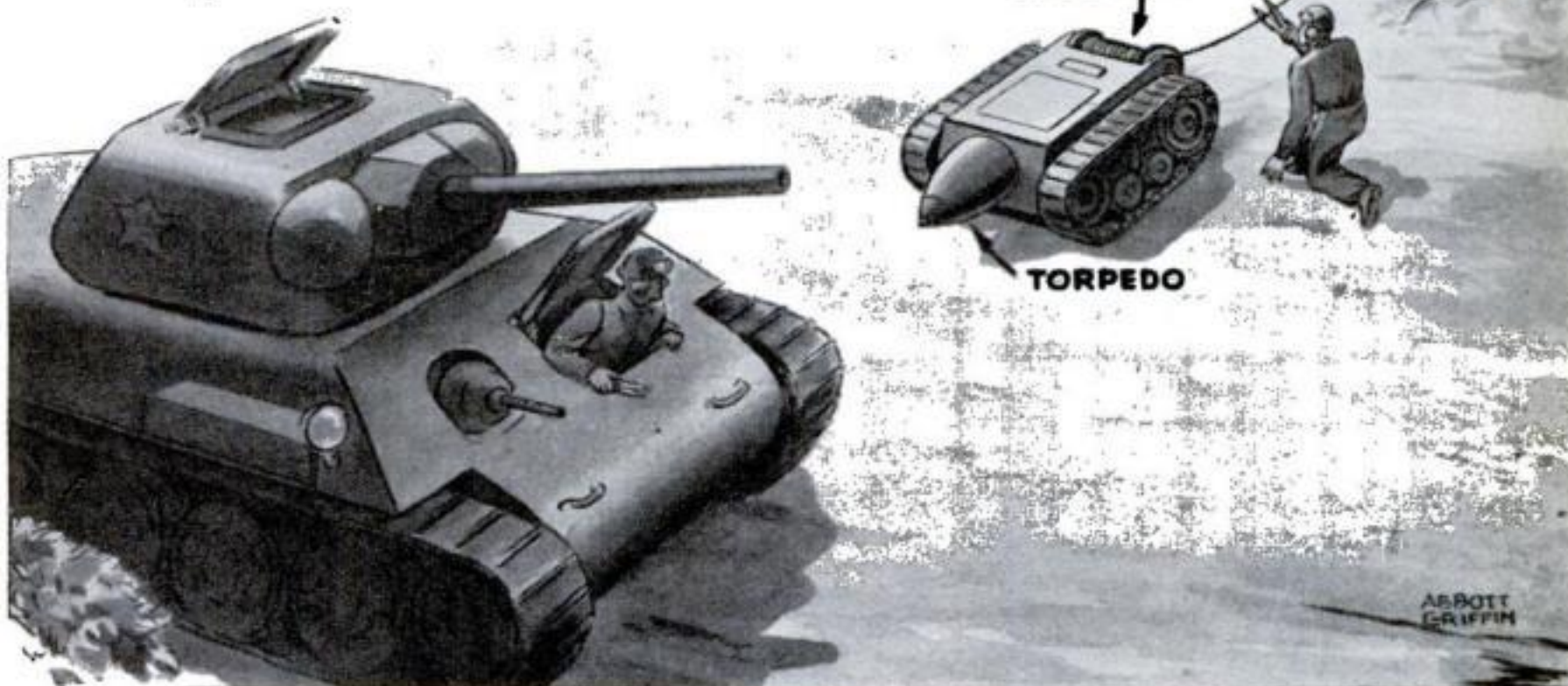
A MORTAR BOMB developed by J. Wauters, of Brussels, has a tail, containing the propellant, that drops off after the bomb leaves the muzzle. In this way the center of gravity is moved forward to make the bomb's flight more accurate. A loose ring around the bomb's waist fits snugly into the bore to conserve the charge's pressure.

INCENDIARY BULLETS have now been designed to carry their own supply of oxygen in an easily shattered capsule so that, even though they lodge in a substance that would tend to smother them, they may still be able to perform their fiery mission. The designers are W. R. Bluedorn, of Hartford, Conn., and R. N. Nelson, of Black River Falls, Wis.

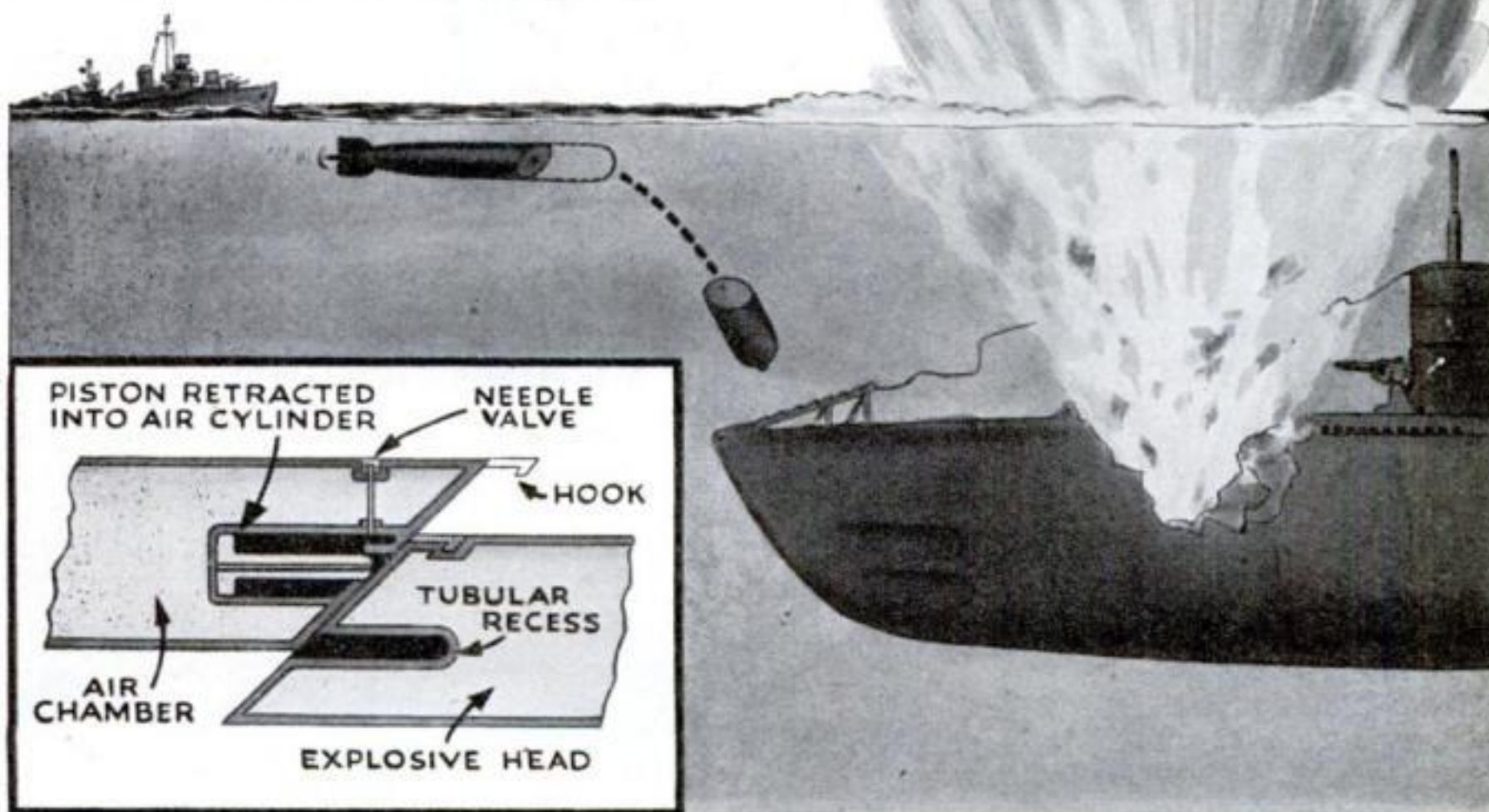


PARACHUTISTS, leaping through the side door of a large plane, always face the danger of their 'chutes fouling some part of the ship. To prevent such an accident, which may kill the jumper and cause the ship to crash, T. W. Sweich, of New York Mills, N. Y., suggests a hatch, located in the rear of the plane, through which a parachutist could jump and almost immediately be far clear of the fast-departing ship.

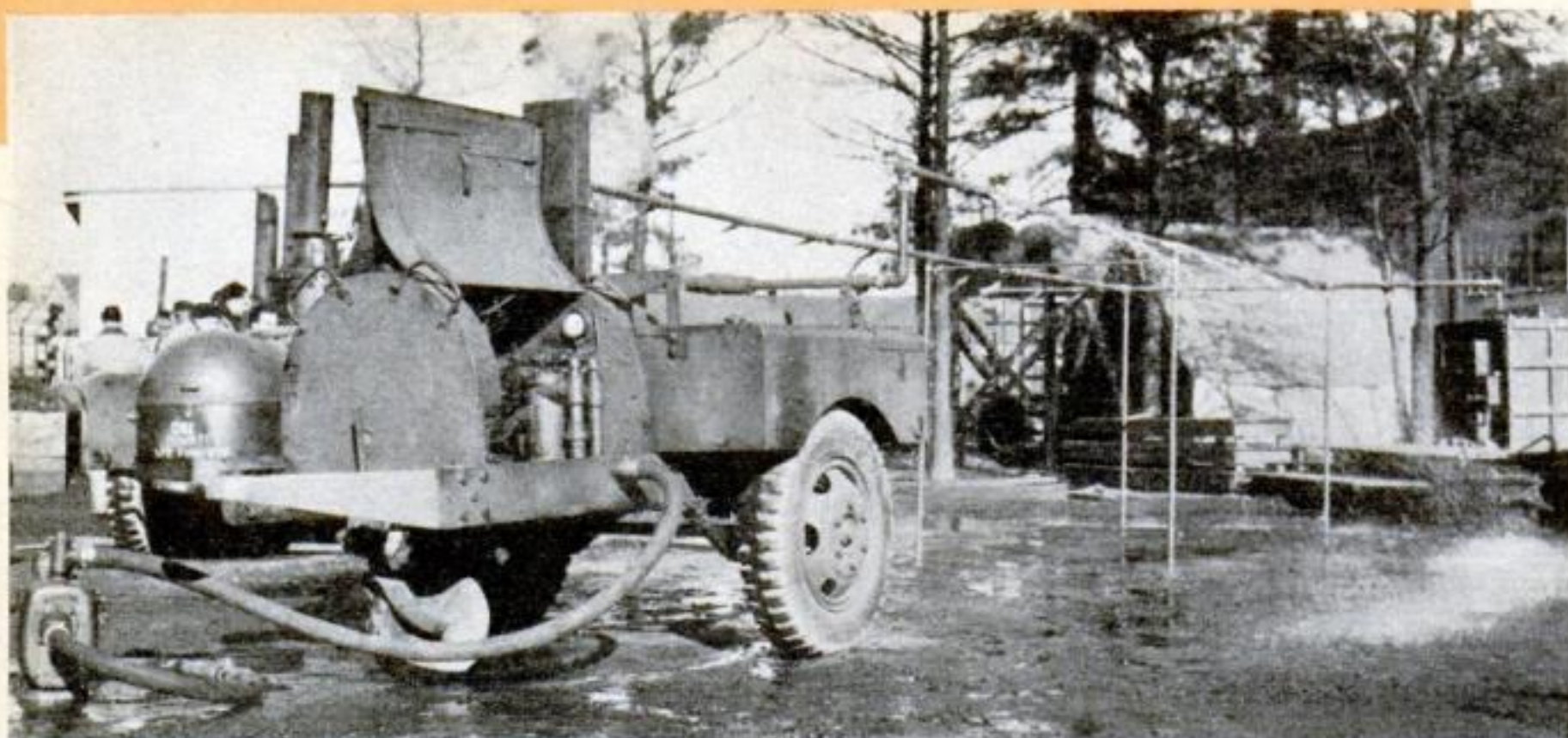
"CREWLESS TANKS" used by the Nazis against U. S. troops in Italy have been of two kinds: one powered by a two-cylinder gasoline engine and controlled by a trailing electric cable; the other driven by radio-controlled dual electric motors and capable of 16 miles per hour. Neither type has been successful on any front as the former is easily hamstrung by soldiers who snip the cables, while the latter can be picked off without difficulty by artillery waiting their approach. The radio "tankettes" carry 150 pounds of explosive.



TORPEDO AND DEPTH CHARGE are combined in a new anti-submarine weapon offered by A. R. Ferrer, of San Francisco. Fired from a torpedo tube at a surfaced sub, it runs for a predetermined distance. If the target has submerged in the meanwhile, the explosive head is dropped automatically to act as a depth charge, but covers more area than an ordinary one.

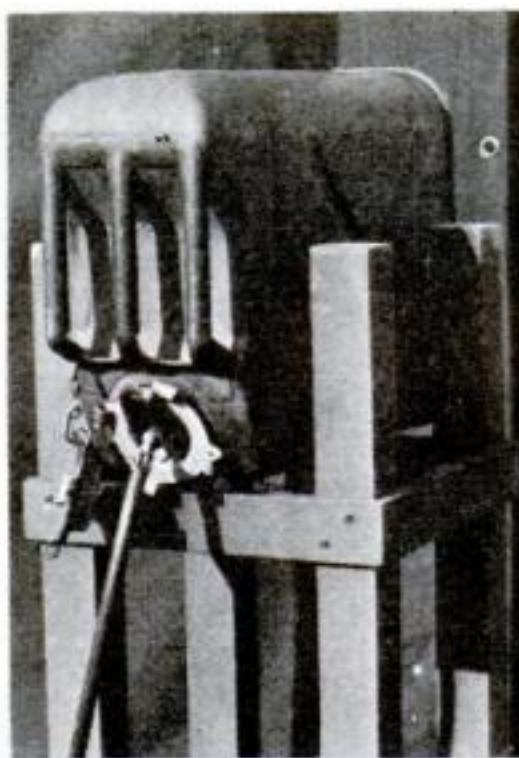


Yank Inventors Meet Army Needs



A MOBILE 24-MAN SHOWER, developed at the Quartermaster Replacement Training Center, Camp Lee, Va., has now been adopted by all branches of the service. The unit consists of a gas-driven 3,000-gallon-

an-hour pump, a collapsible frame for the 24 shower heads, and a heater that warms the water to about 105 degrees F. Trailer-mounted, the unit can be compactly folded for transport by air.



Any standard Army gasoline can will serve as a source of fuel for the new tent-stove converter so long as it is raised a foot or so higher than the unit itself. The feed tube is of synthetic rubber. Diesel oil and kerosene may also be used

"TENTING TONIGHT"

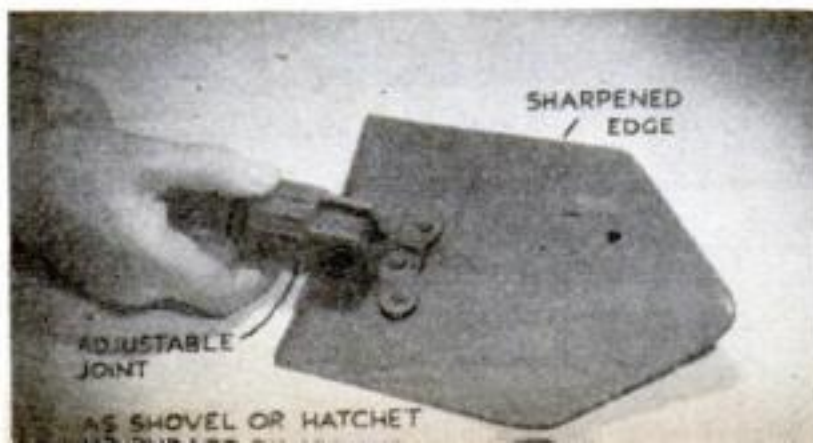
is going to be a lot more comfortable for our soldiers with the gasoline converter the Quartermaster Corps has devised for use with standard wood-burning tent stoves. Fitting on the base of the stove, the converter has a float chamber and a regulating mechanism similar to those on the ordinary circulating oil heater. Kerosene or Diesel oil may also be used, the regulator having separate adjustment markings for all three fuels. Lighting the stove is done through the opening at the top. Once it gets under way, the unit will rapidly heat up the average tent. Feed line is of synthetic rubber.



A HOE-SHOVEL that can be quickly converted from one implement to the other is the neatest answer yet to the problem of a compact intrenching tool. Swinging on a hinge, the blade can be held in either position by an adjustable sleeve, or folded flat for carrying. One side of the blade is sharpened for use as a hatchet.



AS A HOE



SHARPENED
EDGE

ADJUSTABLE
JOINT

AS SHOVEL OR HATCHET



General Arnold, AAF commander, has described the A-20 as "one of the war's most striking examples of versatility." Carrying a battery of .50 cal. machine guns, this version has been "styled" for the job of strafing

Name Your Job... The A-20 Does It

**REVERSING THE TREND TOWARD ONE-PURPOSE PLANES,
THE HAVOC HAS PROVED THE VALUE OF VERSATILITY**

By **JOHN E. LODGE**

Drawings by **STEWART ROUSE**

THIS is the story of a resurrected airplane—a ship that was taken off the stag line of possible operational equipment to become one of the most versatile craft of the war and the undisputed leader of its class. Its manufacturer's serial is the Douglas DB7; the British bought it as the Boston and renamed it the Havoc; our Army Air Forces list it as either the A-20 or P-70, depending on application; the Nazis flatter it with

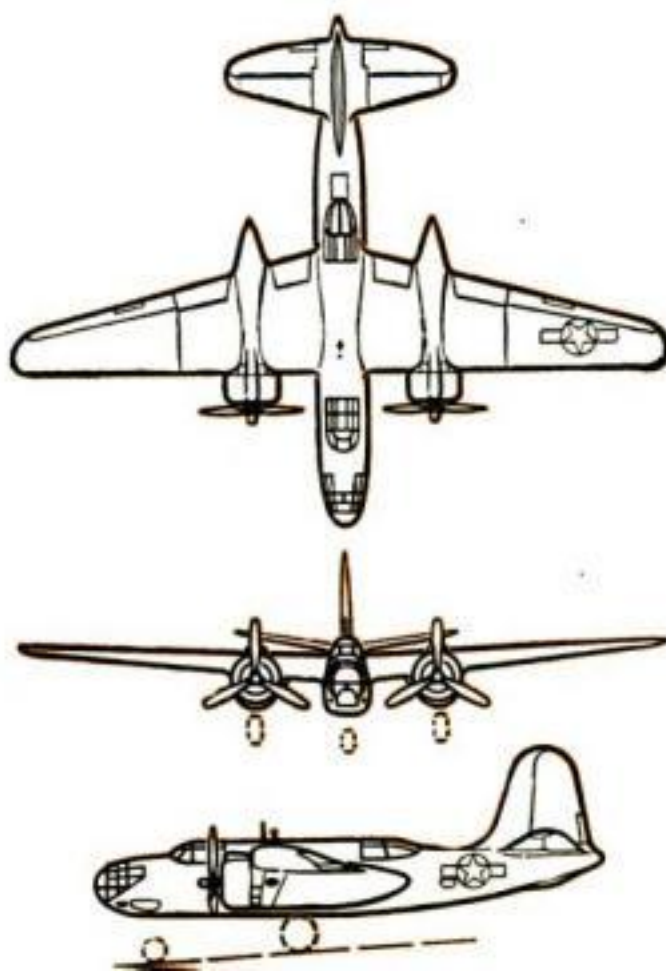
MAIN "SPECS" of the A-20, shown in three views at right, are: wing span of 61 feet; length, 47 feet; number of crew, four; maximum speed, over 320; cruising speed of 280; tactical radius of 300. For its power plant, it has two 1,700-hp. Wright engines

such cognomens as *Nachtteufel* (night devil).

The A-20 has been operated by night as well as by day, in virtually every theater in which the United Nations face the armies of tyranny. With machine guns, cannon, and bombs, it has been used to attack every

imaginable form of military equipment: aircraft on the ground and in the sky, surface vessels, tanks, locomotives, pill-boxes, radio-ranging installations, antiaircraft emplacements, troops, and barges, to name but a few. Its excellence has led air tacticians to go back to the multipurpose basic airframe that can be modified to almost any use.

When the war was young, most experts believed that the special-purpose airplane was the





OLD HANDS at bombing and strafing the Germans from an A-20, First Lieutenants Gentry and Brock and Flight Officer Nicholson take a flyer at a bit of gin rummy while vacationing at a U. S. West Coast redistribution center. Veterans of over 50 missions, they are awaiting reassignment to action

key to air victory. The Stuka and the ME-109 seemingly had proved the case for the special plane built for fixed conditions. When the *Luftwaffe* knifed its way through Poland and France, the men who believed in multipurpose planes began to lose faith. The Battle of Britain served to convince them further of the possibility of error, when the short-range, fast-climbing, heavily armed Spitfires and Hurricanes, facing German fighters operating out of their natural range, pushed the Nazis out of the sky.

This case for custom-built aircraft stood up as long as the air war remained a fairly local problem. When the radius of action began to stretch out and the ground problem could no longer be "preset" to suit the airplane, the single-engined fighter and fighter-bomber began operating at a definite disadvantage.

With almost dramatic suddenness, there appeared a Cinderella plane that could probe into the vitals of industry in Occupied France by day, and then fly against *Luftwaffe* airstrips by night. This was a plane which the British had sedately named the Boston. Like the ne'er-do-well son of a well-bred family, the craft raised such hob that it had to be renamed the Havoc. Here is how it happened:

When the Germans were building Messerschmitts and trying their sting on the hap-

less flesh of Spain, Pierre Cot, the pilot-Air Minister of France, conceived the idea that the single-purpose airplane was limited in a war of vast space. Aircraft defending France would have to possess both range and firepower. Under his guidance, such types as the Potez light fighter-bomber were developed. The history of treason in French industry is now legend. Cot, however, stuck to his ideas and went abroad for the ships French manufacturers could not or would not build in sufficient numbers. The United States produced two planes for this purpose; one was a type known as the DB7, designed in line with 10 years of active research by our Army Air Forces. What finally evolved from the demands of the French for mass-production aircraft, and the operational and structural data gleaned from the old B-18 Dragon and the B-23 anti-sub patrol plane, was a 61-foot shoulder-midwing monoplane powered by two 1,350-hp. Wright 14-cylinder, two-row radial air-cooled engines.

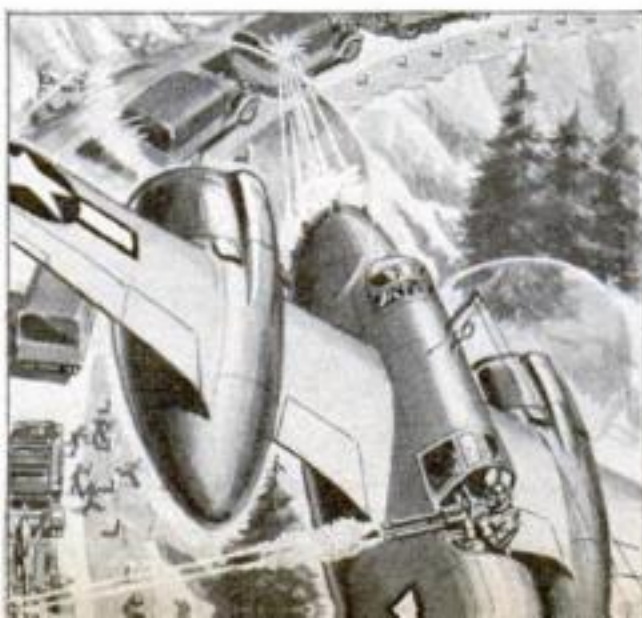
The ship's structure is rugged, simple, and straightforward, designed for maximum strength and ease of production and maintenance. The fuselage—which seats the navigator-bombardier up front behind the wide Plexiglas nose, the pilot in a cockpit just ahead of the wing's leading edge, and the gunner-radio operator aft of the wing's trailing edge—is built in two longitudinal sections, plus a nose and a tail unit. This

AN ALL-AROUND PLANE, THE HAVOC TAKES ON MORE JOBS

BOMBING. With characteristic versatility, the A-20 can work at medium altitudes or with fragmentation bombs at tree-top levels



STRAFING. Enemy supply columns and troop concentrations are easy pickings, especially for the P-70 version with a concentration of nose guns



SKIP BOMBING. Bouncing an egg into a hangar door or through a factory window is a sure way to get results. It's a pet trick of the hedge-hopping A-20's



form of split-up allows each piece to be subassembled and completely rigged with all accessories before it is put together to form a fuselage.

The wing consists of three parts: a center section, onto which the two power eggs, or engine nacelles, are hung, and two outer wing panels. The center section contains the landing flaps, or air brakes, while the outer panels contain the ailerons. The tail plane, consisting of the elevators and stabilizer, is rigged with 10-degree dihedral angle (turned up from the horizontal plane) to give the ship more directional stability on take-off.

The ship is equipped with a fully retractable tricycle landing gear. The main wheels retract backward into the engine nacelles, while the nose wheel moves backward into the front end of the fuselage. The combination of flaps and tricycle landing gear was desired by the far-sighted French leader, who saw that great air installations would probably be the first targets, and that the combat planes would have to be dispersed to operate from small, ill-conditioned fields. This handling feature gave the DB7 one important phase of its great versatility.

Unfortunately, France fell before this splendid design could serve under the tricolor. England, in desperate need of aircraft, was buying almost anything that could taxi. The twin-engined light bomber was not just what she needed, but it was a plane in production, so the RAF took over the order. For several months, the Boston did sedate day-bombing missions alongside Britain's Beauforts and Blenheims. However, the crews that flew Bostons started techniques of their own. They hopped over into enslaved France, hitting targets that were considered "walled" with anti-aircraft. Their record against the *Luftwaffe's* fighters began to look like that of a pursuit type. By the time the heroic RAF had wrested the air initiative away from Germany, something new had to be added to



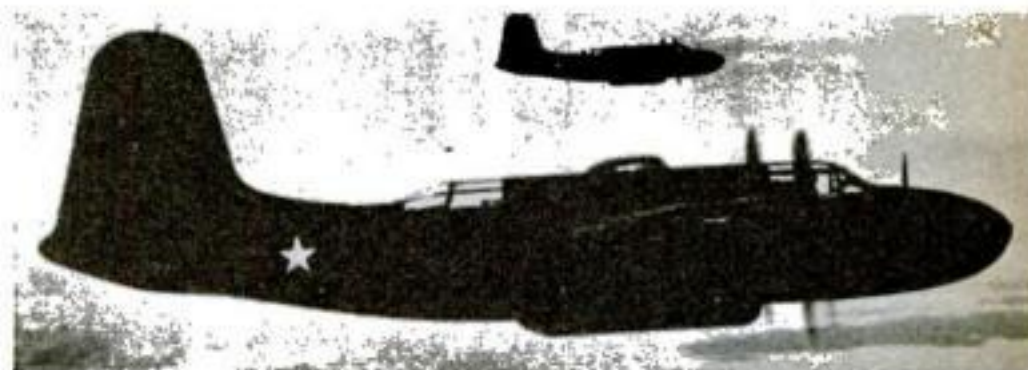
THE DOUGLAS B-18, with its short nose and fat belly, is a prototype not only of the A-20 but also of the DB7 bought by France in 1939 as an all-purpose ship



THE B-23, successor to the B-18, had its fuselage made smaller, its nose narrowed and lengthened, and was then put to the rather inglorious job of sub hunting



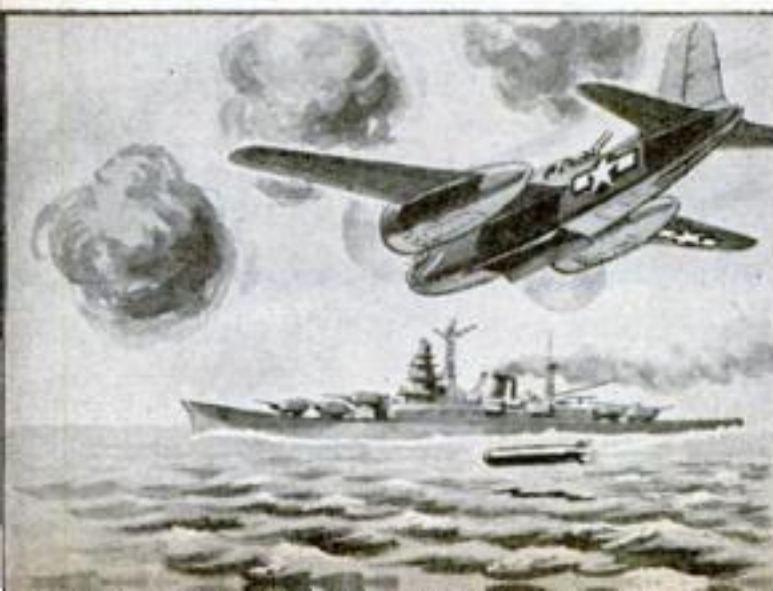
THE BOSTON is what Britain first named our A-20. It wasn't long before she was calling it the Havoc and the battered Germans had dubbed it the "night devil"



THE P-70, new Army night-fighter version of the A-20, has four 20-mm. cannon mounted in a flat belly turret

ON MORE FRONTS THAN ANY OTHER AMERICAN-BUILT SHIP

TORPEDO BOMBING also comes natural to them. Flight characteristics of the Havoc give it a good chance to send its "fish" home—and get away safely

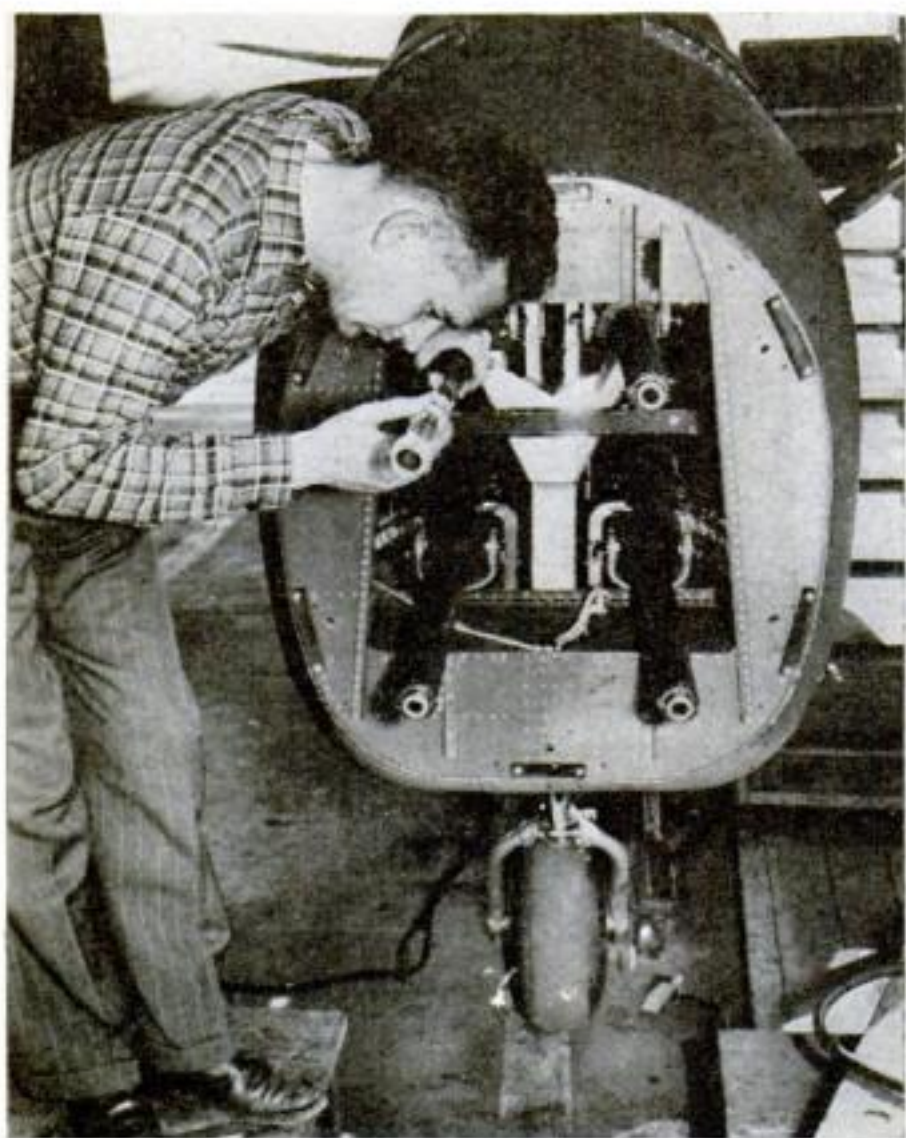
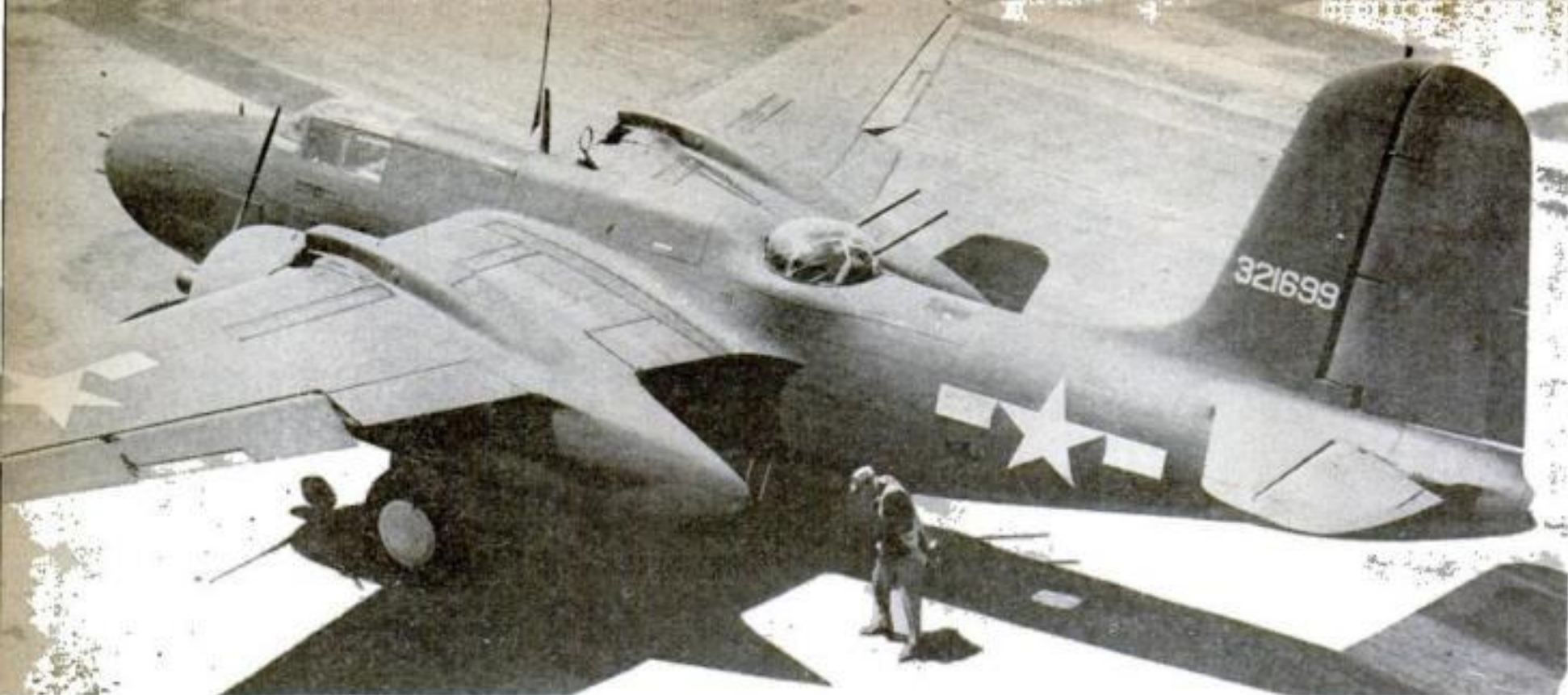


FIGHTING is the job for which the P-70 was born. Early success in night intrusion for the British showed the Havoc's aptitude as a night fighter



SMOKE-LAYING. Trailing dense clouds, these low-flying planes screen our advancing troops and blind the enemy. (See page 84.)





LATEST ADDITION to the ever-changing A-20 Havoc is a power-driven top turret housing two .50 caliber machine guns. Considered the fastest attack bomber the U. S. has yet put into the air and possessing amazing maneuverability, the Havoc, with a total of nine .50 cal. guns by virtue of this added armament, now moves into the fighter-bomber class. At the left, a special optical device is used to bore-sight the four 20-mm. cannon that are nose-mounted in one version of the P-70

with two guns in the nose and two in side blisters, as well as two flexible guns for the radio man, one in the top scarf mount and one below, shooting through the floor. These planes prowled around the enemy airdromes, waiting for heavily laden bombers to attempt to take off. Just as a ship gathered speed, a DB7 would hop in and either strafe it or drop a bomb right in front of the plane. Between the RAF bomb and the detonation of the German's bomb load, the noise could frequently be heard across the Channel. Failing to catch the planes on take-off, the Douglasses would trail them home from the target. By that time, the German planes would be shot up and low on fuel and ammunition. When they thought that they were safe within sight of home, the DB7's would come in, catch them with their flaps down, and finish them off by the glare of their own field lights. It's small wonder that the name of the staid, well-mannered U. S. city was lifted from the type, and a true description of its function put in its place—Havoc.

By the time the U. S. got into the war, the theory of custom-built fighters had been pretty definitely *(Continued on page 222)*

the air fleet, a night fighter that could hit the night raiders over their own bases.

Between the accurate electronically directed anti-aircraft and the short-range night-fighting Spitfires, life over England was a pretty precarious proposition for German airmen. However, the RAF weren't satisfied. They wanted to thin the Germans down at both ends of the operation as well as in the middle. The Boston was painted a dull velvet black, fitted with flame dampers over the exhausts, and heavily armed

P-70 NIGHT FIGHTER

HERE'S the fighter version of the versatile A-20 attack bomber, caught in characteristic action by the brush of Jo Kotula. Night fighting is no new chore for this plane-of-all-work. Early in the war, the British set the Havoc to hijacking Nazi bombers over their own airfields. Now, with a battery of guns and designated P-70, it makes its bow as a full-fledged fighter.





How Jap Spies Fooled Us

AGENTS USED CLEVER RUSES TO STEAL OUR WAR SECRETS

Drawings by Frank Hubbard, based on an article by Fred Henry in "U. S. Naval Institute Proceedings."



BARBER SHOPS run by Japanese in Panama were little more than blinds for photographic darkrooms hidden in the rear. In recent years Japs have become expert in the use of all kinds of cameras.



RIGHT UNDER OUR NOSES. a month before the Pearl Harbor disaster, packing cases full of files from Japanese government bureaus were shipped back to Japan from San Francisco headquarters. The shipment enjoyed diplomatic immunity.

INFORMATION gathered by a Tarawan banker regarding installations at Arubon, where Australians landed, passed from a ship captain to a consul to Tokyo itself.



QUESTIONED LOYALTY to Nippon meant that the Jap under suspicion rated a place in this list, which was detailed, up-to-date—often damning.

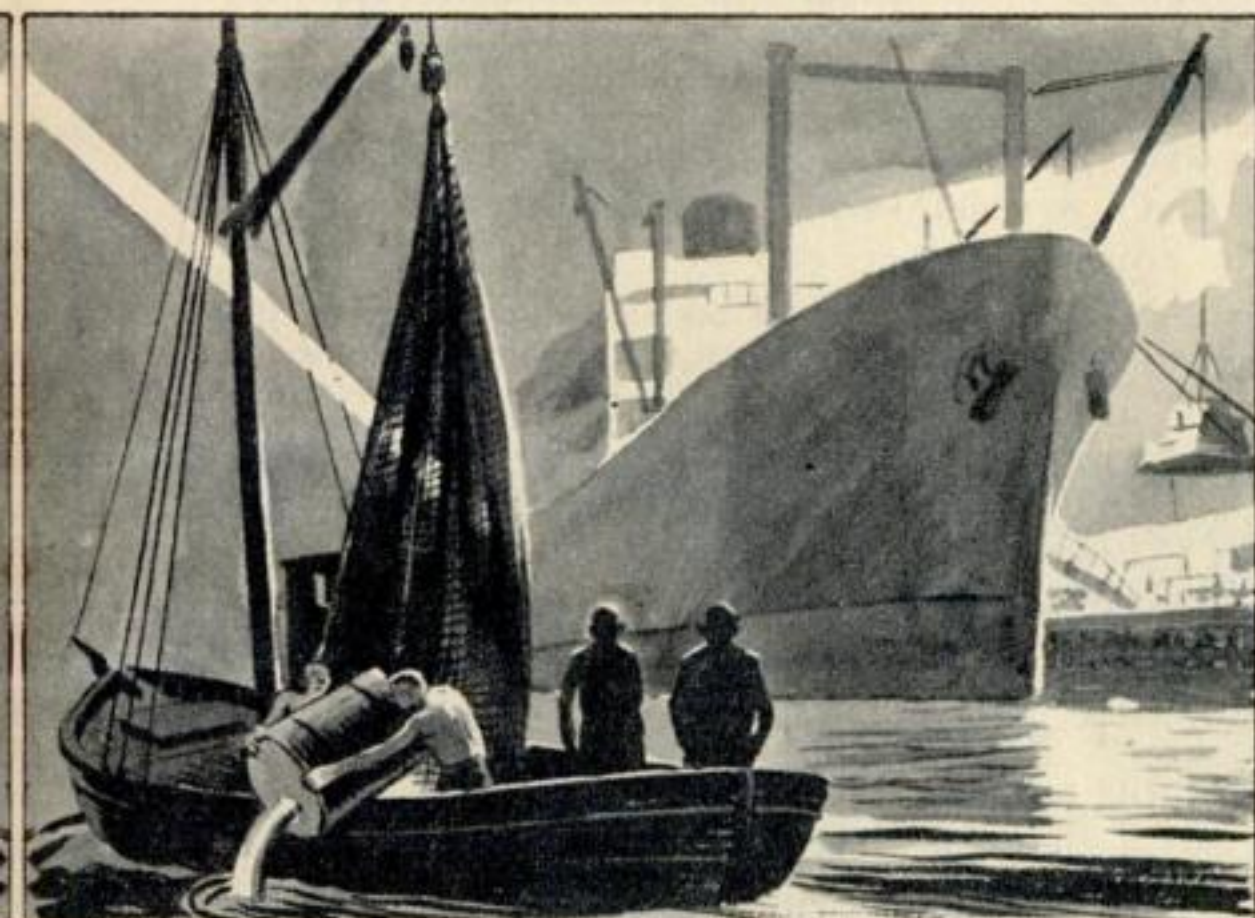
JAPS CRAVED information in 1934 regarding the Los Angeles water system. Official requests were not heeded, so 13 Japanese-Americans got Civil Service jobs in the city's water works department, all placed so they could get the facts.



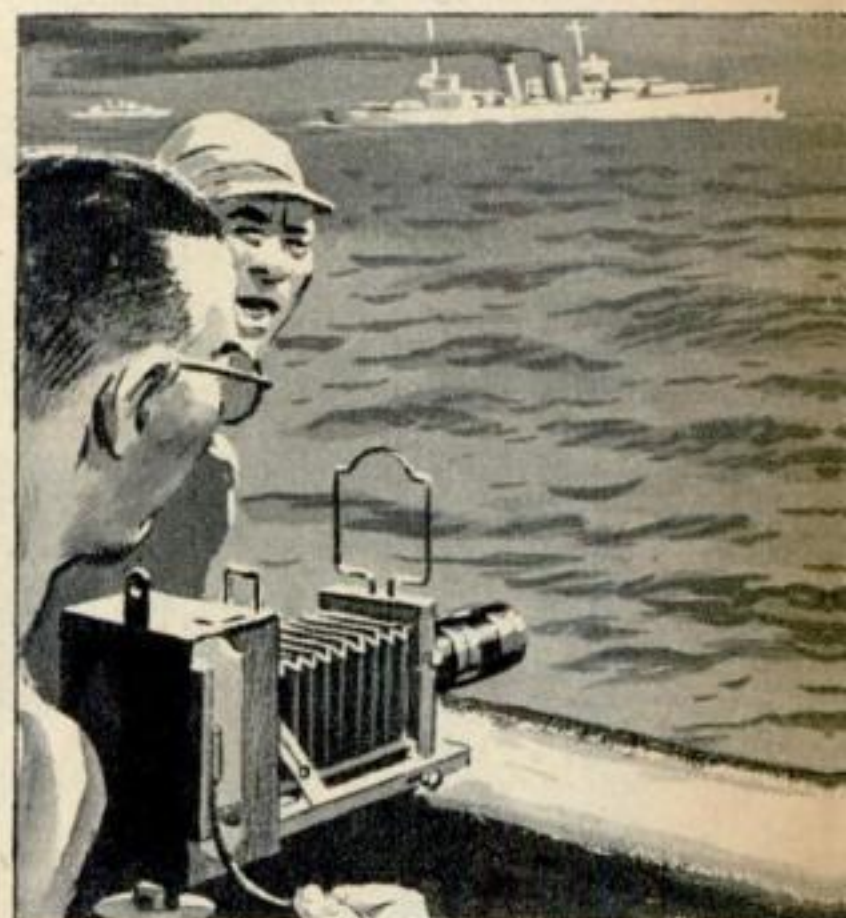


FISHING BOATS, costing as much as \$200,000 each and expensively fitted, were engaged in constant espionage on the Pacific Coast. They were equipped with Diesel engines, and had a cruising range of

6,000 miles. They fished with vertical lines, close to shore, for the obvious purpose of making soundings, and they kept contact at all times with their master's voice in Tokyo by means of a short-wave radio.



CHEMICAL INFILTRATION also added its corrosive action. Into a Hawaiian harbor Japs dumped an acid substance which, mixed with salt water, attacked the plates of a freighter so that during the time of loading they were a quarter eaten away.



IN DIRECT VIOLATION of naval anchorage regulations at San Pedro, Calif., the "Nippon Maru" photographed the new U. S. cruisers "Astoria" and "Quincy."

"WHERE FORTS LOCATED?" Japanese tourists blandly asked for such information, hoping that by their apparent guilelessness they could avoid suspicion.

TONS OF QUARTZ for radio equipment were bought up at the California gold mines by the far-seeing Japs. This now-important item in the field of communications was an undesirable by-product at the time, and went begging on the market.



Where There's Smoke/ There's No Fire!

The spectacular fireworks of chemical warfare now save soldier lives by blanketing the enemy with haze or flame to paralyze his resistance.

By HAL BORLAND

Photographs by HANS GROENHOFF

THE hour for attack approaches. Ground forces are already on the move. At a hidden airfield, chemical-warfare trucks pull away from the six medium bombers they have finished loading. Armorers are still packing ammunition into strafing and

ground-support planes. The bombers warm up, race down the runway, are off.

The objective of the attack is a broad valley flanked by rocky hills

pocked with antiaircraft and ground artillery that commands all the valley's approaches. As the bombers come in, one element heads for each hillside. Ack-ack blossoms around them. Then the bombs fall, and as each bomb strikes, it mushrooms into a white cloud with towering, fiery streamers. In half a minute both hillsides are smothered under white phosphorus

White phosphorus has the highest TOP (total obscuring power) of all the smokes produced by the Chemical Warfare Service. Here is a cluster of WP bombs at the moment of bursting. Spontaneously combustible, phosphorus begins to fume and make smoke as soon as it is released to the air by explosion





Phosphorus bombs that generate heavy clouds of white smoke also have an incendiary effect. This photograph shows one of them exploding in daylight, throwing out long streamers of flaming phosphorus that will spread smoke over a large area to the complete discomfiture and confusion of enemy forces

smoke. Shortly, the ack-ack fire dies away.

Even as the bombers turn back toward their base, the pursuit ships sweep in under them and roar up the valley in their first strafing run. There is virtually no ground resistance. Then the ground force itself arrives, moving in to wipe out the smoke-enveloped gun crews, to take and hold the valley. Attack becomes victory.

That's one way chemical warfare works today, saving lives, speeding victory. The old saying about smoke has been reversed. Now it goes:

"Where there's smoke there's *no* fire"—no enemy fire cutting you to pieces before you get a chance to deliver your blow. For chemical warfare is an integral part of attack as well as a potent element in defense. On every front we are literally smoking 'em out.

Our chemical arsenal is an amazing thing to behold, particularly in action. And today it is only one of the multiple resources used in combined operations, as exemplified at the Army Air Forces Tactical Center, at Orlando, Fla. The Center is both a tactical school and a proving ground where all branches of the armed forces review the lessons of combat and rehearse new techniques of combined operations. Most of these operations involve chemical warfare.

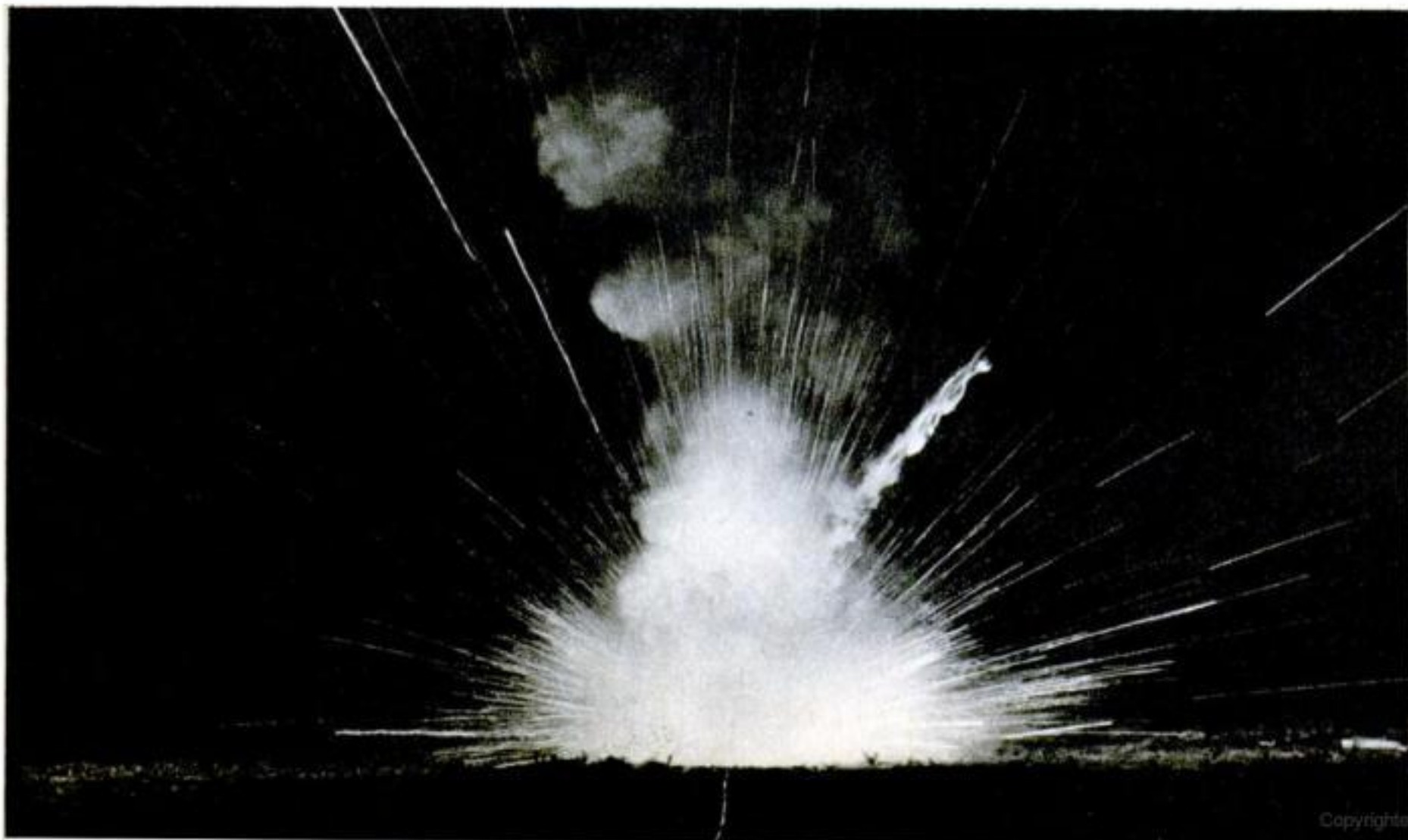
Broadly speaking, chemical warfare has three principal weapons—smoke, sprays, and incendiaries. All these may be used, as the situation dictates, from the air, from the ground, or on the water. And all may be used directly, as in hand-thrown gre-

nades or with smoke pots or generators, from airplanes in the form of bombs, or from mortars and other artillery. And all have offensive as well as defensive uses.

Most of today's military smoke is a chemical cloud rather than the kind of smoke that billows from your fireplace when the draft is wrong. White phosphorus stands at the top of the smoke list with the highest TOP, or total obscuring power. Spontaneously combustible, it begins to fume, sputter, and make smoke as soon as it is released to the air. Primarily a smoke producer, it has important secondary uses as an incendiary and against personnel. It is used in grenades, in aerial bombs, and in shells. In the Pacific it has been used more than any other smoke agent to smother artillery fire and clean out ack-ack emplacements. In Europe, the Germans fear it more than any other smoke producer; its fumes do no damage, but its contact burns are frightful. And its smoke is most effective.

Next on the list is HC smoke. It gets its designation from hexachlorethane, which, with zinc powder, produces a dense gray cloud. HC is used in grenades and smoke pots, and is peculiarly effective in smothering machine-gun nests, offensively, and in covering landings or protecting against enemy bombers. The HC floating smoke pot is handier than a jackknife. It can be tossed from any kind of boat and will continue to fume even after repeated submersion. In emergencies, this floating pot has even been strewn around harbor fronts and along beaches by scurrying jeeps, for it works as

MAGNESIUM INCENDIARY BOMBS burn with terrific heat. They usually are dropped from planes to destroy enemy matériel in the areas attacked. In each cluster a certain number contain an explosive charge that scatters their fire and also is injurious to anyone who is within a radius of 50 to 75 yards





JELLIED-OIL BOMBS just after their initial explosion, with tank and infantrymen silhouetted against the smoke cloud and its flaming streamers. These bombs contain bags of sticky, viscous, inflammable oil, which are ignited and flung out when the contact fuse sets off the bursting charge. The burning oil sticks wherever it hits, and is particularly damaging to matériel depots or grounded aircraft. Incendiaries also come in the smoke category because they often are used to spread a dense pall over installations

Sputtering with an almost blinding brilliance, and throwing off billowing clouds of smoke accompanied by blast-furnace heat, a cluster of magnesium incendiary bombs, dropped from an airplane on an enemy installation, is extremely damaging to enemy morale as well as matériel. In a 100-pound magnesium-bomb unit the cluster consists of 34 individual bombs, each about 2½ inches in diameter and 18 inches long





Most spectacular among Army's chemical vapors is the brilliantly colored smoke generated by grenades and used in signaling and identification, from tanks and ground forces chiefly to airplanes. Soldier is shown pulling safety from grenade preparatory to releasing firing pin. Grenade is three inches thick

Some of the colors available from smoke grenades. For signaling, the Army seldom uses more than three colors at a time, but there are six from which to choose, besides black and white. The smoke is
 88 generated without flame, and each grenade provides about 15 minutes' worth of chromatic functioning



effectively on land as it does in the water.

Add to these the M-1 smoke generator (P.S.M., July '43, p. 62) and its smaller brothers, and you have an all-round smoke arsenal. The M-1 generator looks like an antique fire engine and will belch clouds of dense smoke for hours with a minimum of attention. Early models were so big that they required special trailers, but now there are little ones that weigh 200 pounds or less and can be snaked into place by jeeps or even by hand. Used defensively, such generators masked one Mediterranean port so effectively that Nazi bombers in 10 successive raids put only one bomb anywhere near the port installations. They have also been used with telling effect to blank out enemy artillery in landings and in ground offensives.

There is one more smoke agent of particular importance—FS, or fuming sulphuric acid. It is used as a spray, or in bombs or artillery shells. Its utility depends largely on the humidity in the air, for the acid combines with air moisture to form a thick cloud. FS is also used in breakable grenades, which are tossed into foxholes or smashed against enemy tanks.

Most spectacular of all the smokes, however, are those produced by the colored-smoke grenades. Their primary purpose is for signaling. The first ones were developed for distress signals to be used by airmen forced down in the Arctic. They produced a vivid red smoke that could be seen for miles. Experience showed them to be so visible from the air that a whole series of such grenades, with a range of color, was developed.

They are now used for communication between ground and air forces. Tanks, for instance, are hard to identify from the air. In North Africa, one group of Stukas unmercifully bombed a formation of German tanks by mistake. Our own tanks now identify themselves to friendly planes by tossing out colored grenades in a predetermined sequence; today the sequence may be red, green, red, and tomorrow it may be green, blue, yellow. In the same way, artillery or infantry can identify themselves to friendly

IT'S GOING TO CLOUD UP. Armorers load smoke makers on plane. (1) Spray tanks being taken from trailer to be filled with chemical. (2) As tank is filled with the corrosive liquid, a crew member stands by with a counteracting agent in a spray gun in case it spills. (3) Two chemical spray tanks are now attached to one wing of the waiting plane, while another tank is brought up for the other wing. (4) Wiring for the percussion caps that burst diaphragms over vent and outlet is hooked up with a switch in the cockpit of the plane. When they are empty, these spray tanks can be let go by the use of the pilot's bomb release. Photographs were made at USAAF Tactical Center, Orlando, Fla.,





LAYING A SMOKE SCREEN from the spray tanks under the wings of two A-20's. A spray job of any description can be done from any altitude between that of a pursuit plane at tree-top level and a big bomber at a height of 15,000 feet. The same equipment can be used to lay a blanket of any kind of gas

planes or even summon emergency air support.

These colored smoke producers are relatively new, and new uses are being developed every day. They are about the size of a pint milk bottle, and their smoke comes in red, orange, yellow, green, blue, and lavender, with black and white to supplement them. They are neither explosive nor incendiary.

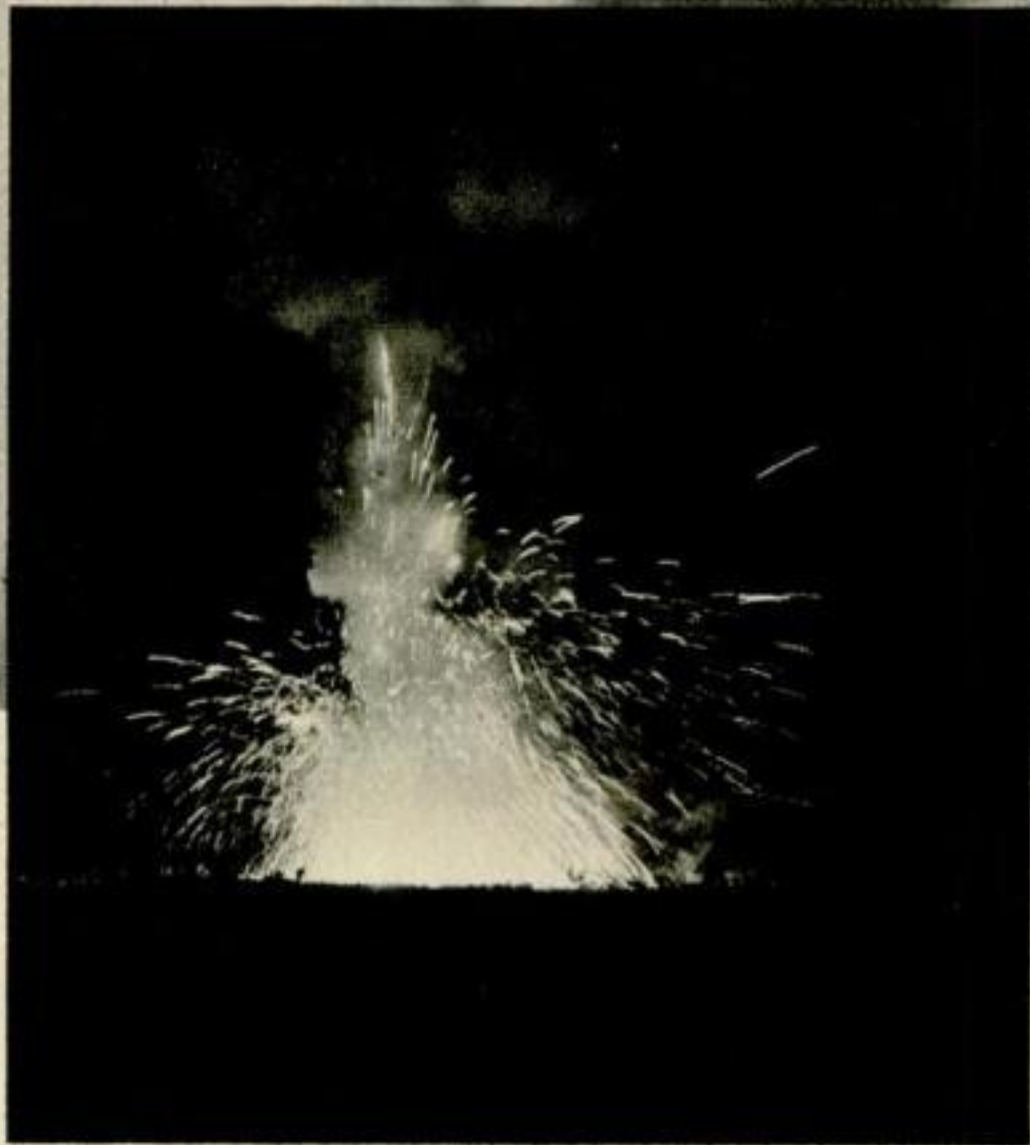
As indicated for FS, smoke and other

agents can also be laid over any area by spraying from planes. Two types of spray equipment are available; these are the pressure tanks, which use compressed carbon dioxide to force the liquid through a spray nozzle, and the simple gravity tanks, from which the liquid flows to be atomized by the slip stream. The Army uses the gravity tanks almost exclusively; they weigh less, are simple to operate, and can be attached to any bomb rack. In size they range up to



WHITE PHOSPHORUS GRENADE

A soldier, shown on his belly in the foreground, has thrown the grenade into a foxhole, where it explodes with almost blinding brilliance and spreads a great volume of heavy smoke that obscures everything within a wide radius. Primarily a smoke producer, phosphorus has an important secondary use in incendiary missiles



THERMITE INCENDIARIES

Above is a B-25 sowing a cluster of incendiary bombs. At left is just one item in the resulting harvest of fire, a thermite bomb exploding on reaching its objective. Thermite burns stubbornly at about 4,500 degrees, which is more than 20 times greater than the heat of boiling water at sea level. Thermite is composed of a mixture of aluminum powder and an oxide of iron

the giant that is as big as a 1,000-pound bomb and can be carried only in the belly of a big bomber. There are lesser tanks, of course, that can be slung under the wings of a P-38.

A spray job can be done from any altitude. Pursuit ships can sweep in at tree-top level and lay a smoke screen directly, medium bombers can drop a pall from their ideal flight level, or big bombers can cover a huge area from 15,000 feet up. And this same equipment could be used to lay a blanket of any kind of gas. This, remember, is smoke equipment, but if the need arises,

these same containers can carry and spray anything from tear gas on through the list of toxic chemical agents. Nobody talks about that possibility.

Going on to incendiaries, one enters a field of secondary smoke weapons. The primary purpose of incendiaries is to destroy enemy matériel, but they also come in the smoke category because the fires they set often spread a blinding blanket over defensive installations of all kinds. And there are even defensive incendiaries, chiefly grenades, which can be used to destroy matériel to keep it from [\(Continued on page 192\)](#)



Atlantic

Active service in the Atlantic Zone entitles a seaman to this War Zone Bar



Seamen's Emblem

For every man who ships out, irrespective of destination



Pacific

Indicates Pacific Zone duty. A combat bar is added for enemy action in whatever area



Mediterranean

For service in Middle Eastern and Mediterranean waters. A sinking rates a star



Mariner's Medal

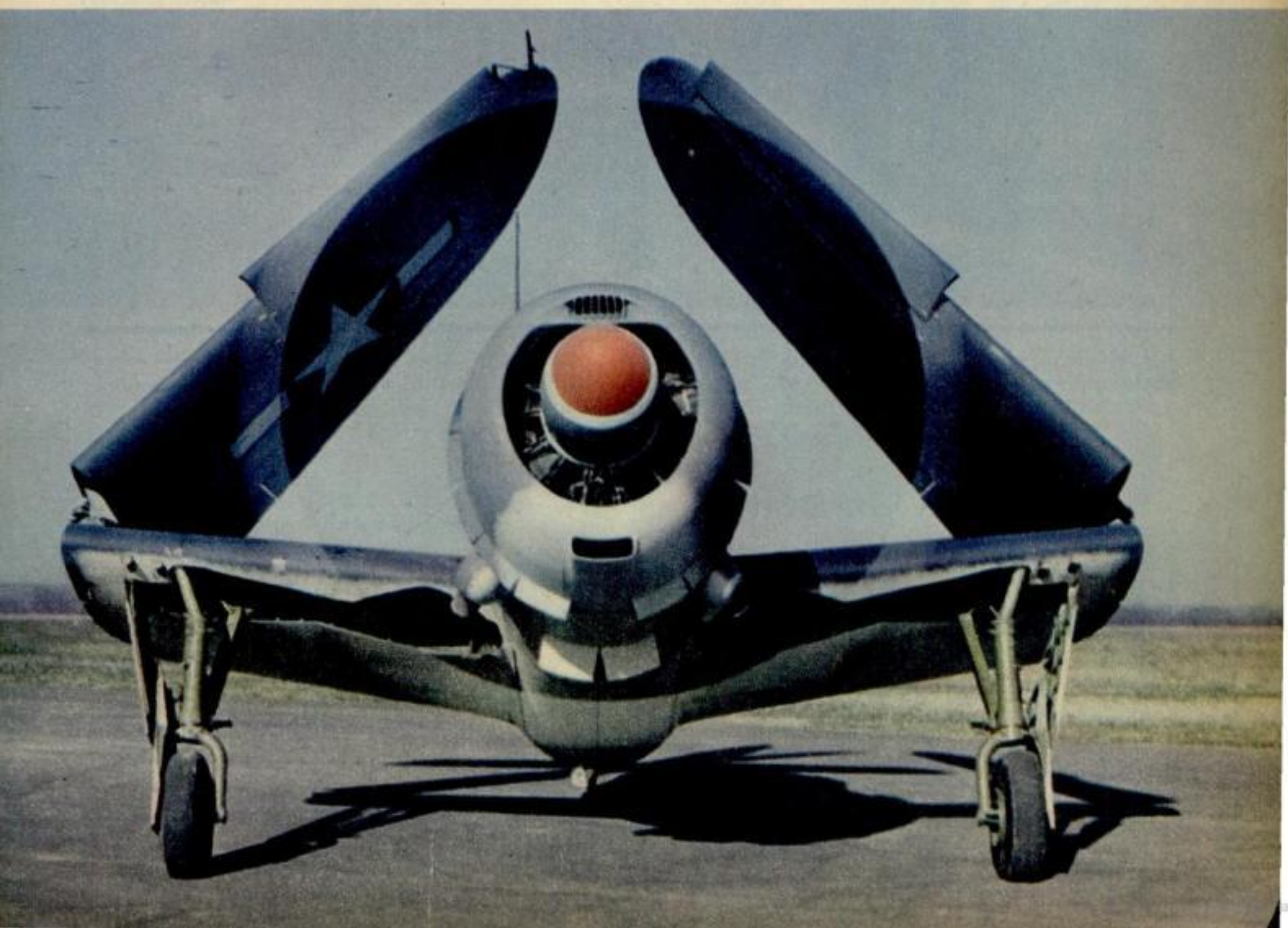
Recognition for merchant seamen who are killed or wounded in enemy action


MERCHANT seamen now rate a variety of medals, War Zone Bars, ribbons, and lapel buttons for service in war zones. With each award, the War Shipping Administration issues a certificate describing the service for which the decoration has been given. The above are only a few of those authorized.



ARGUS is the British alias of this Fairchild, which wears the RAF insigne on the same liaison and light-cargo errands that it performs for the USAAF as the C-61 Forwarder. Top speed, 110; range, 555. Payload, four passengers or 1,000 pounds.

AT REST with folded wings, the Navy's Curtiss Helldiver dive bomber plainly shows the "eyebrow" slats on leading wing edges which give it high controllability for carrier landings. Also note openings under wings for retracting gear.





Army Airmen Take 200-Foot-Long Color Photos

How the secrets of enemy-held territory are laid bare on wide, continuous strips of film by pilots flying at six miles a minute.

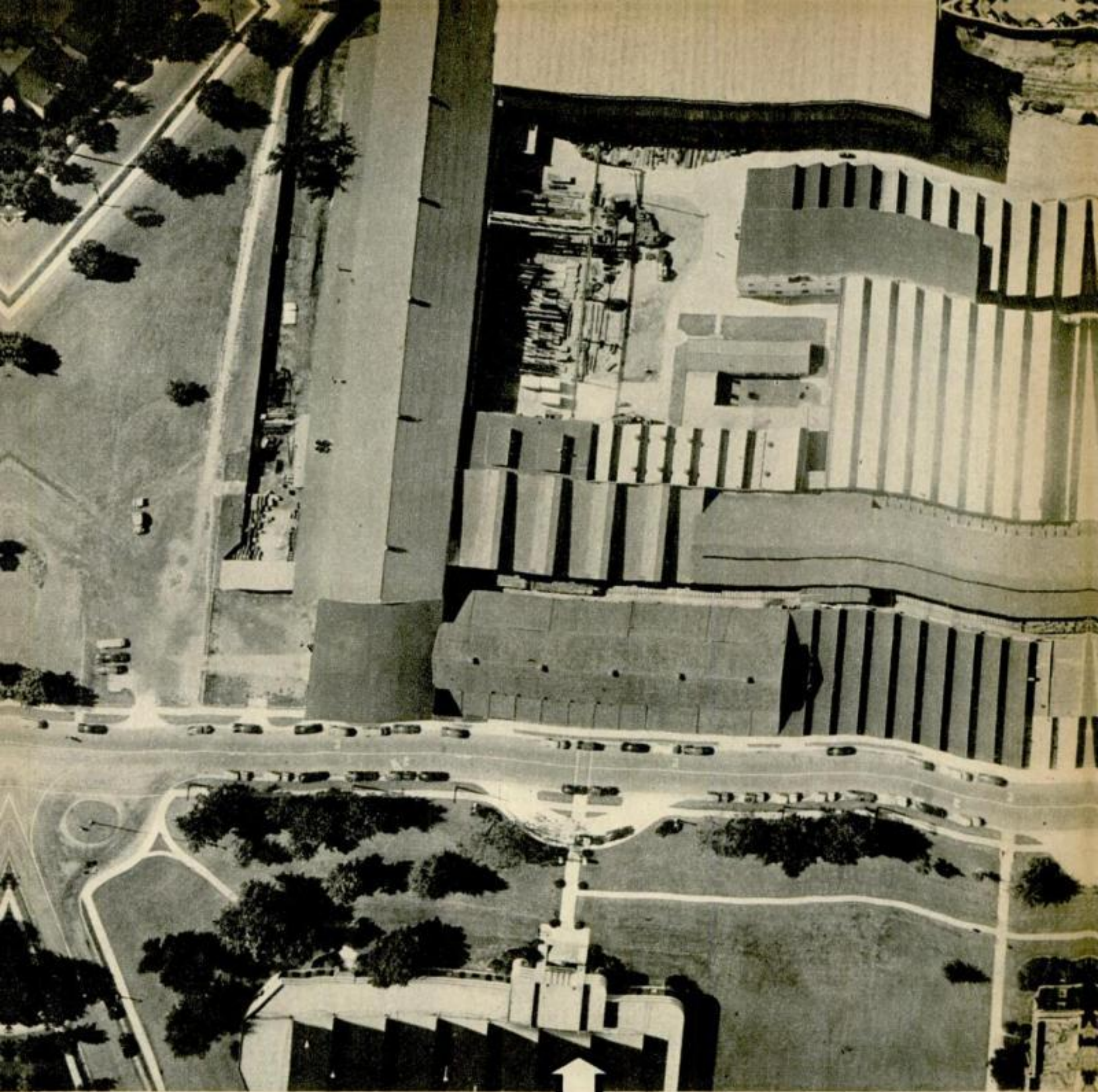
A low-flying pursuit pilot presses the trigger of his camera, and a continuous strip of territory is photographed as he zips along at 400 miles an hour. This sample strip continues across four pages. It was all in color originally, but is shown partly in black and white to demonstrate the marked contrast

By **GOLD V. SANDERS**

LIKE a continuous observation platform a hundred feet or so above the enemy's lines—that is how you might describe the all-revealing strips of natural-color pictures which our low-flying reconnaissance planes are now providing for staff officers in the field. It is the nearest approach yet to eavesdropping on the enemy, for these brilliantly sharp and colorful shots, all taken vertically with the ingenious continuous-

strip camera, are ripping off most of the enemy's camouflage and robbing him of his ability to conceal and deceive.

Once the bold and skillful reconnaissance pilot is back with one of these penetrating records of what lies "over there," staff officers can study it at leisure, bit by bit. There is precious little that can escape detection in the area that has been covered, which may be several miles long and several hundred feet wide, depending upon the altitude at which it was photographed.



Skill and daring both are required by pilots who take such shots as this of enemy territory. They must hold a straight, level course, and the plane's speed must synchronize with the camera's. Wavy lines in roads and buildings near right margin above show where this pilot allowed his plane to waver slightly sideways

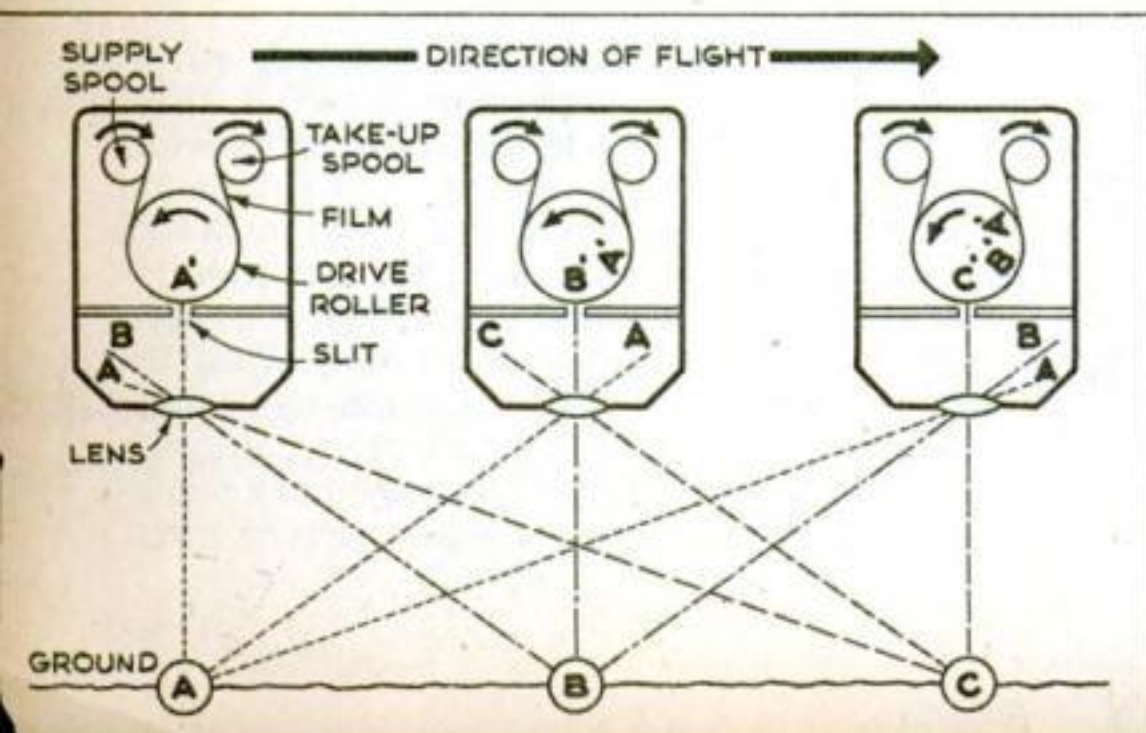
The camera is loaded with a roll of film especially made for this type of work, with a maximum length of 200 feet. The pilot of the swift pursuit plane that is used to carry these cameras need not worry about going too fast. He can get perfectly clear, sharp, and beautifully colored pictures of every detail at 400 miles an hour, and he can get them in a driving rain if need be. The astounding feature of the continuous-strip camera is that, in effect, it gives the pilot a stationary subject, regardless of the

great speed and low altitude of his plane.

There is no comparison between these color strips and black-and-white shots when it comes to spotting the enemy's equipment and installations. It takes three hours to process the color film as against 15 minutes for the black-and-white, but the loss in time is more than compensated for by what the color shot reveals. The human eye is not accustomed to viewing its surroundings in mere shades of gray, such as ordinary black-and-white photographs show. From birth,

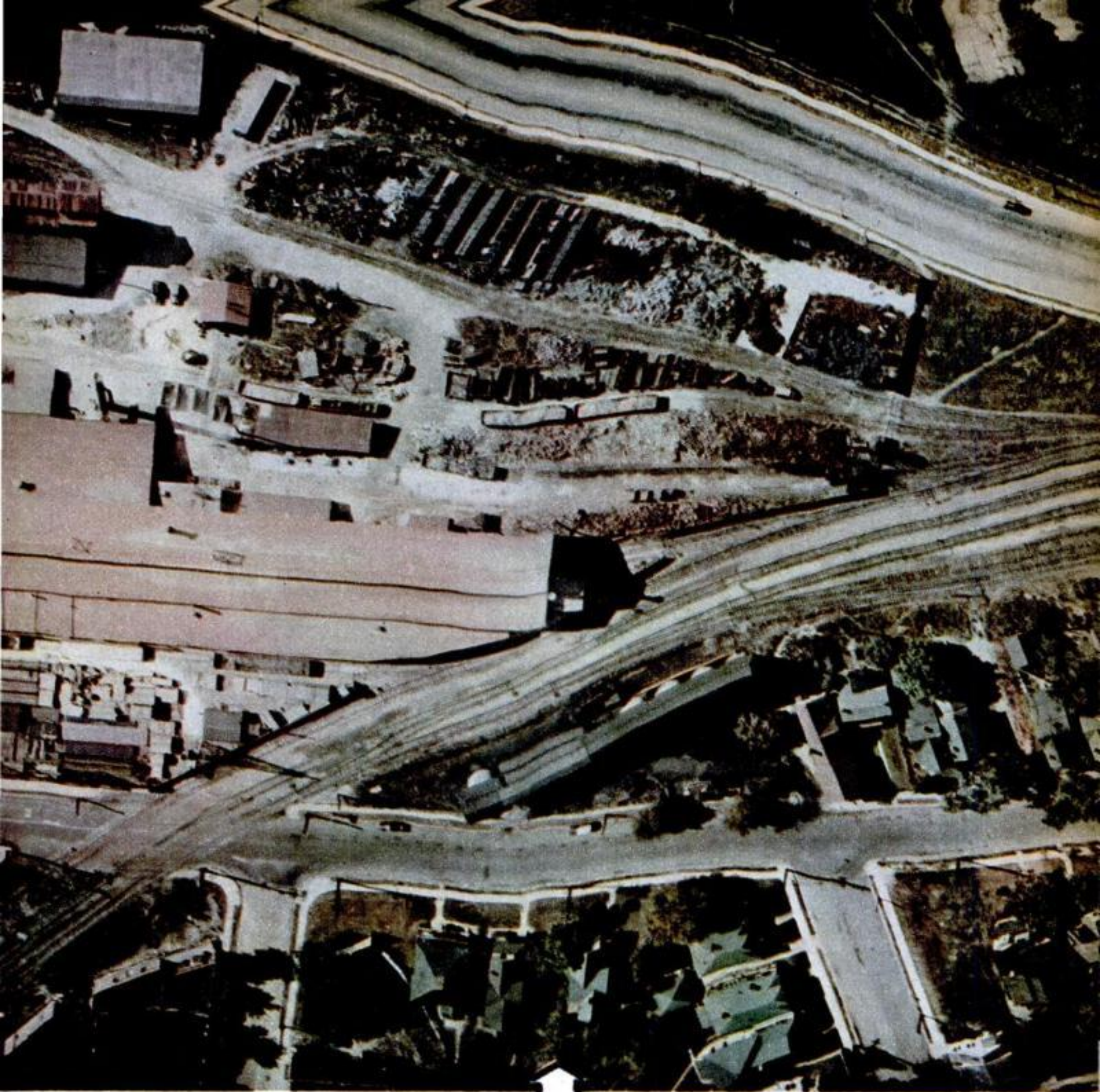


Natural color is much more revealing than black and white. The territory covered by the strip shown on these four pages is 600 feet wide and 2,400 feet long. On the Air Forces film from which this was taken, the scale was 400 to 1; here it is 1,100 to 1. This film was 18 inches wide. Standard film used is 9½ inches



Even though the plane which carries it speeds along at 400 miles an hour, the continuous-strip camera shoots virtually a "still subject." The drive roller feeds the film past the narrow slit at the proper rate of speed to keep up with the plane. All photographs are taken vertically. The point B on the ground does not register on the film until the photo plane is directly above that point, because the image cannot pass from the lens through the aperture. By the time a plane has traveled from A to C, the strip of ground between these two points will have been registered on the film as indicated by ABC on the driving drum

POPULAR SCIENCE



Trained interpreters can tell what is being manufactured in these factories by the form and color of raw and waste materials. Here the photo plane hit a down draft of air (directly above arrow). This drew the plane out of synchronization with the camera, causing a momentary blurring across the entire strip

we have learned to view everything in color, and this is probably the reason why the Army finds it much easier to train picture interpreters on colored pictures than on black-and-white.

A large gun may be hidden in the shadow of a tree. A black-and-white picture will reproduce the gun, the tree, and the tree's shadow all in about the same dark shade, leaving nothing for the spotter to detect but the outlines of the gun, or any part of it

that may be visible. Shoot the same scene in color, and the green of the tree clearly sets it apart from the cannon by color contrast. It is as if the interpreter had been given a new dimension for his observations.

Leaves and shrubbery stuck in a camouflage net might fool the color camera while they are very fresh, but let them start to wither, and the color change will reveal them on color film.

But it is not only on the battle fronts



LATE-MODEL continuous-strip camera used by the Army Air Forces for reconnaissance. Though it is smaller than many conventional cameras, its mechanism makes it possible to take sharp pictures at 400 m.p.h. Photographing can be done even in pouring rain

that the colored film is of value for detection purposes. In preparation for bombing the enemy's industries, color can afford important information. As an example, a color strip showing a factory may reveal what raw material is being used by accentuating its color. Waste material lying about may also reveal a lot. Sometimes even the smoke issuing from an industrial stack has a characteristic color which will tell the expert interpreter what process is going on under the roof. Then, a night or two later, that process may not be going on any more. The bombers have been there.

With the color film used in the continuous-strip cameras, our staff officers get the double advantage of vivid color contrasts coupled with the penetration of the all-vertical photograph taken from a very

low level. There are no wide oblique angles to confuse the scene.

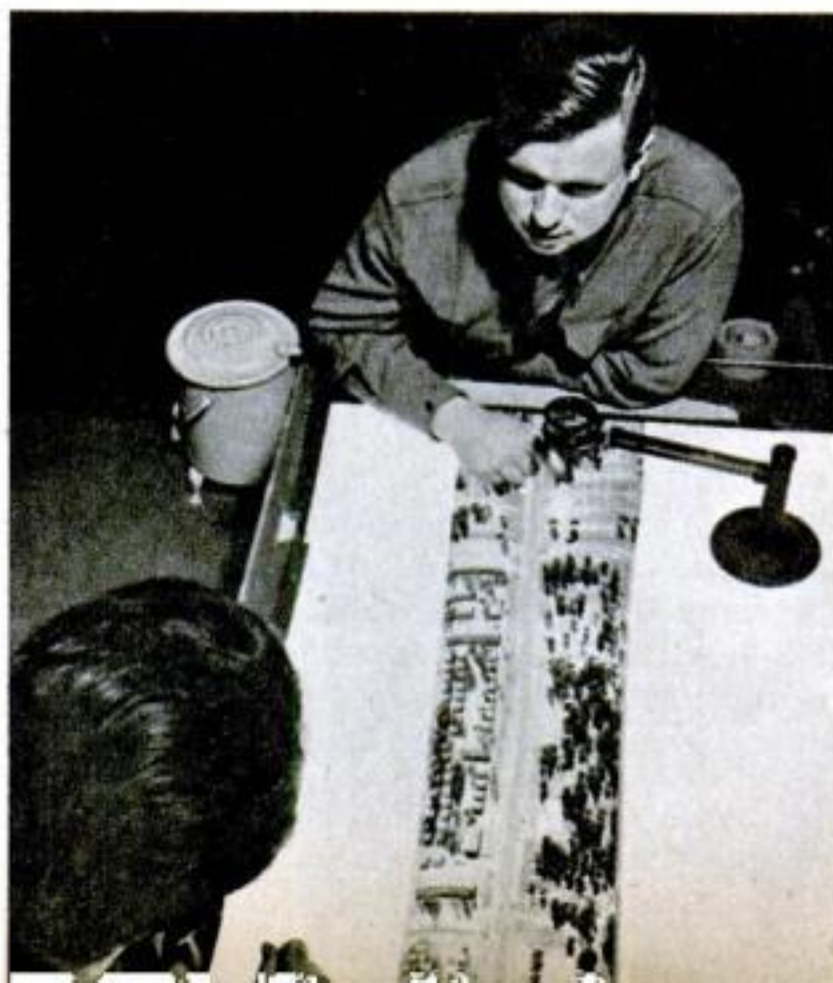
The image of the ground does not enter the slit opening of the cameras until it passes directly under the plane. This slit may be from next to nothing up to a half inch wide, depending upon the speed of the plane and the altitude at which it is flying. The width of the slit is adjustable and governs the length of exposure.

Before this camera was invented, any photographer would have told you that it would be impossible to "stop" the ground and photograph it vertically while flying over it at 400 miles an hour at a 100-foot altitude. The motion-stopping method of these cameras is different from that of conventional equipment. It is more akin to the action of the panoramic camera. The film strip itself is drawn past the slit by an electric motor, and the pilot sees to it that the rate of film movement is commensurate with the plane's speed and altitude. In other words, the film is made to keep up with the ground, or rather with the image of the ground thrown upon the film by the lens.

You can see why it takes an extra-good pilot to do this job well. The fact is that only the cream of the pursuit pilots are chosen for it. If a pilot wigwags his wings a little, corresponding curves will show up in the picture. A railroad will be wavy, and a building beside it will follow the crooked railroad. A bad bump, of course, blurs the whole picture momentarily. These possible errors, however, may not necessarily ruin the picture for observation purposes. Interpreters will be able to make allowances in many cases. A truck will still be recognized as a truck, *(Continued on page 192)*

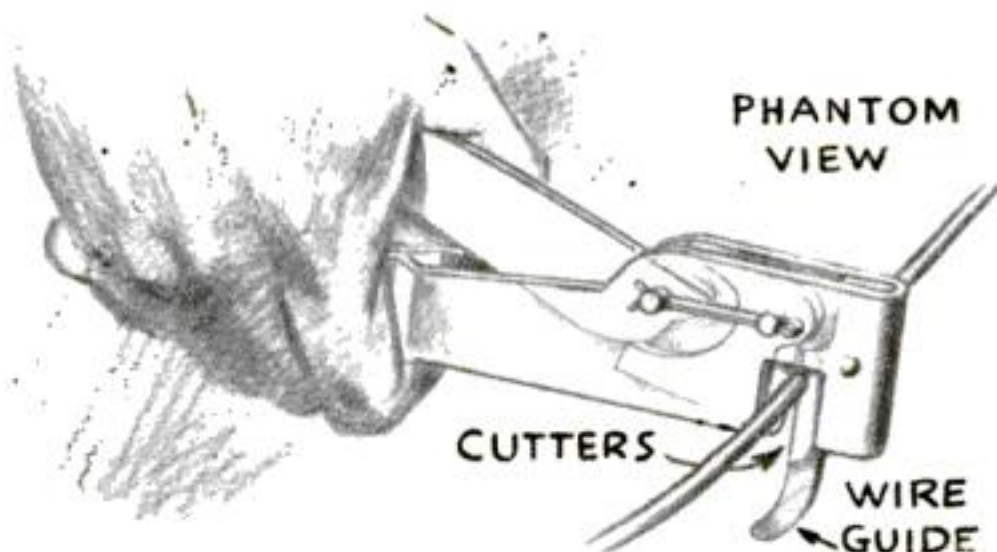
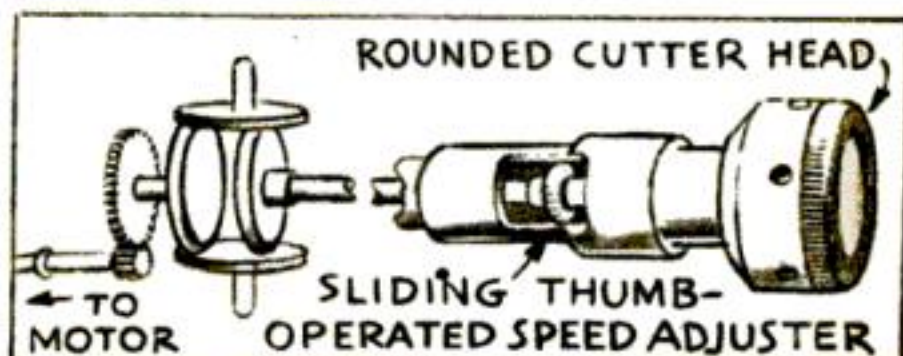
PROCESSING a roll of negative 9½ inches wide. Black-and-white film can be processed in less than 15 minutes. Color film, however, takes three hours, but it is worth it because it reveals so much more

INTERPRETING a photograph—brought home by a pilot after a daredevil dash over enemy terrain—is done by experts trained to spot important areas by the colors of seemingly unimportant details



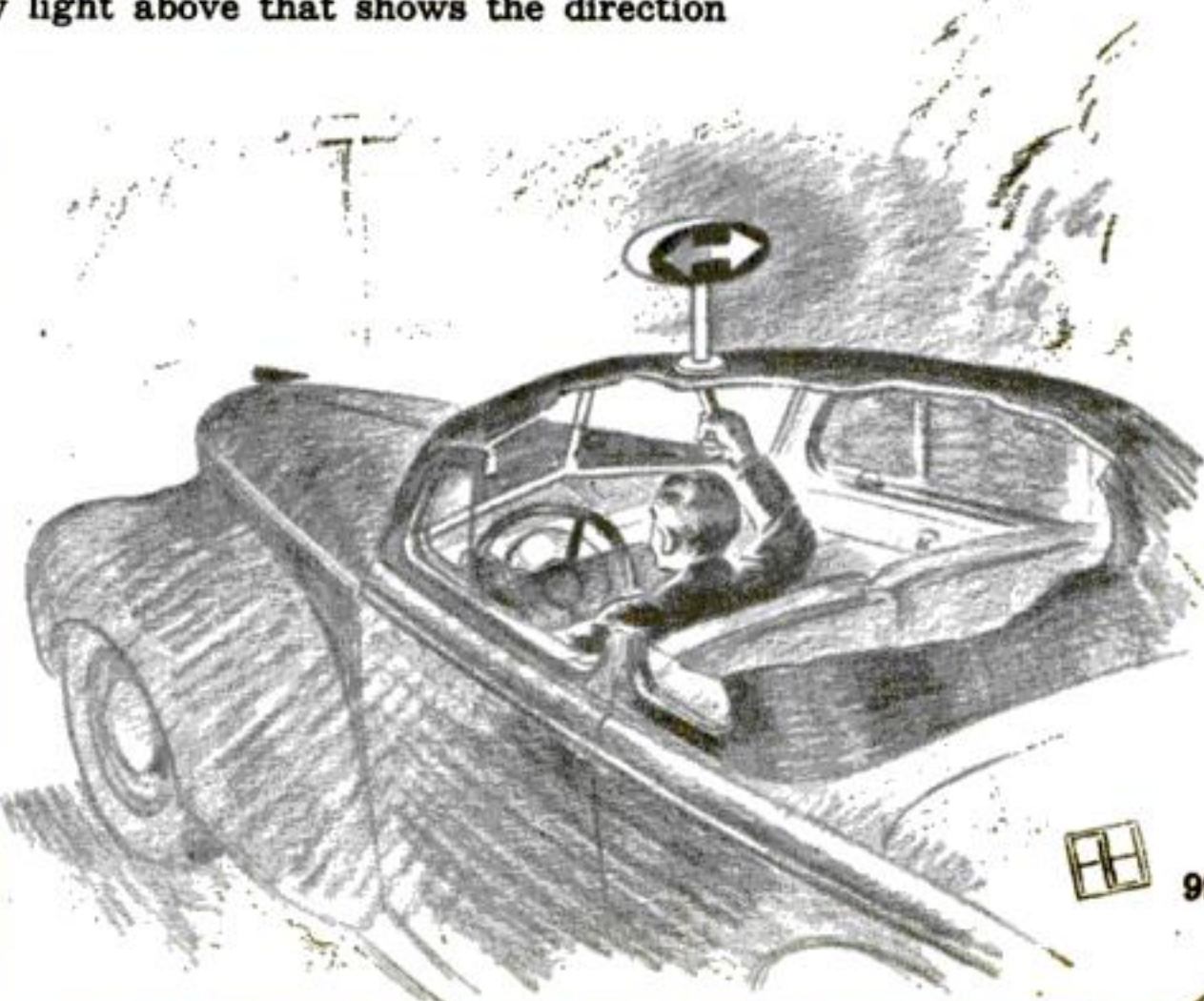
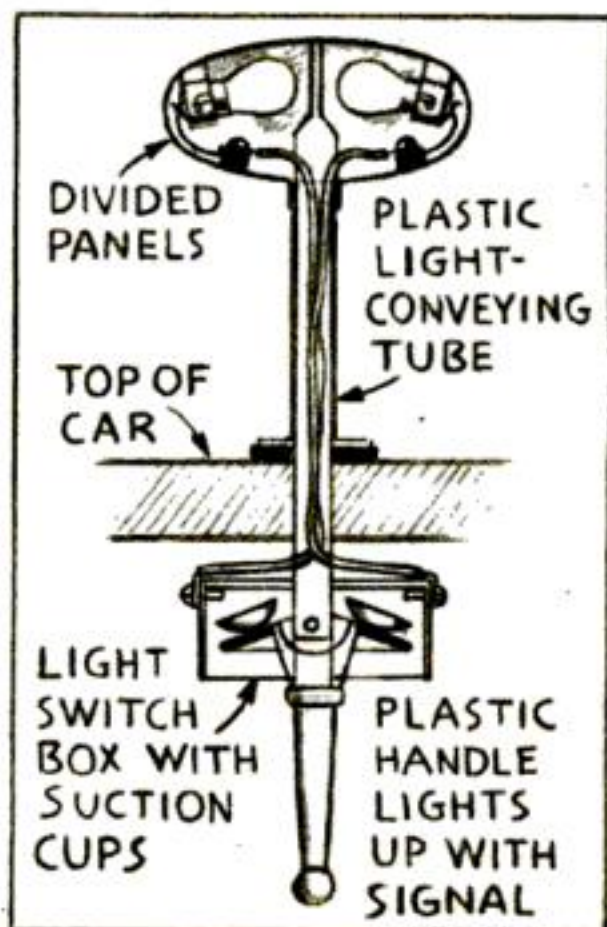
new ideas from the inventors

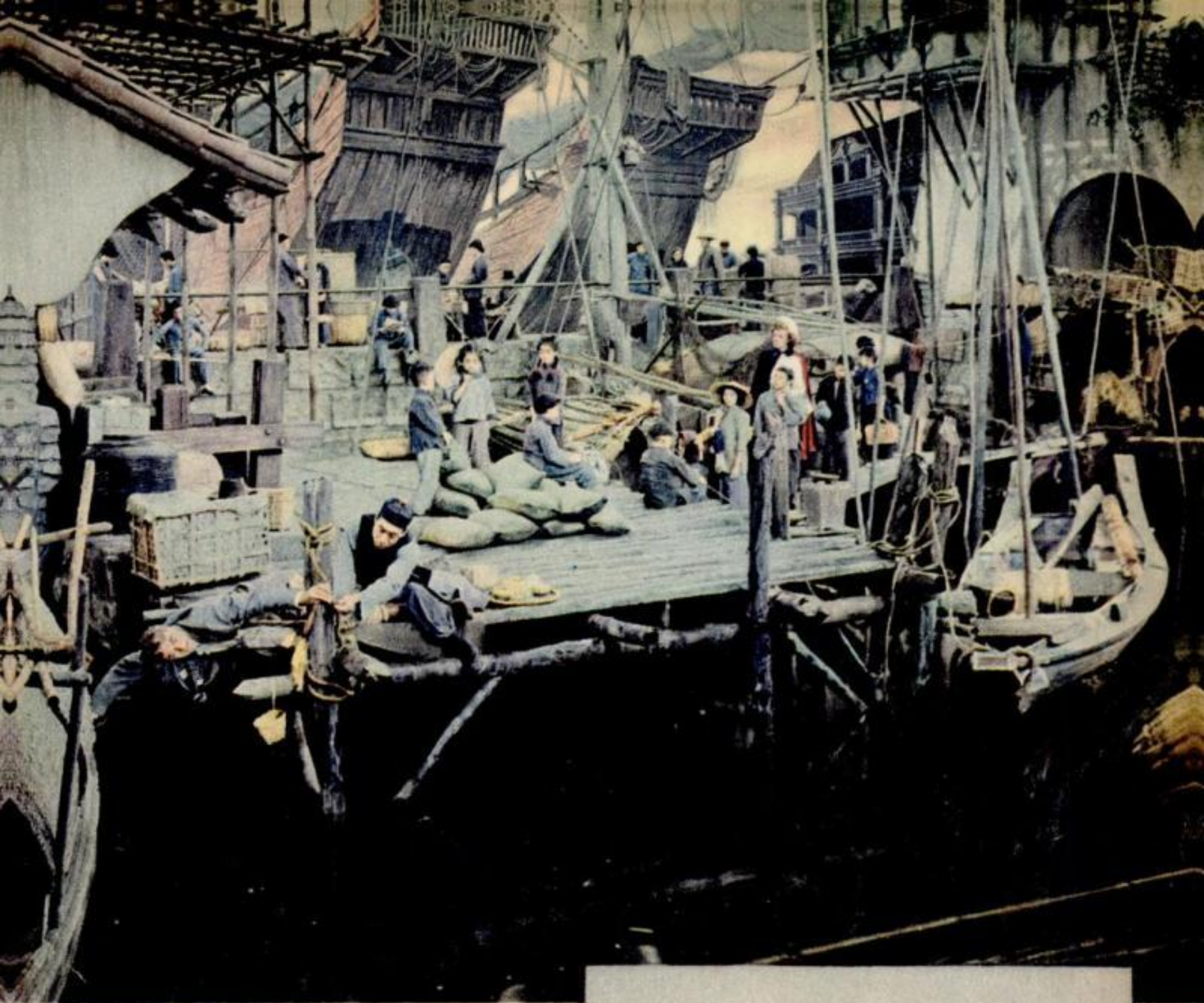
VARIABLE SPEED of an electric razor invented by Joseph D. Wilhoit, Chicago, Ill., and Nace F. Huber, Louisville, Ky., is controlled by the thumb on a sliding roller that moves a rotary disk on the surface of friction-drive wheels inside the handle. The position of the disk in relation to the diameter of the motor-driven wheels governs the speed of the razor's blades. The new shaving device, which is said to be shockproof, has a cylindrical casing that is easily grasped and a cutter head which will receive hair right up to its outside rim. Ventilating holes in the cutter head convey heat away from the part of the razor that comes in contact with the skin during the shaving process.



A CONNECTION between the movable jaw and handle of this new wire cutter provides leverage so powerful that barbed and other kinds of wire can be severed with one hand. Below the cutting edge is a slightly curved hook that guides the wire into the snipper's jaws. The tool was developed by H. W. Romanoff, New York City, and is intended both for war use and peacetime pursuits.

A DIRECTION SIGNAL for cars has been devised by Horace Watkiss, Salt Lake City, Utah. Atop a light-transmitting tube of plastic mounted on the car's roof are two electric lights. These are housed in a translucent casing divided by a partition. A handle extending through the roof to within the reach of the driver can be moved sideways to turn on the arrow light above that shows the direction the car will turn.





Months of painstaking research and labor went into this reproduction of a Shanghai dock, at the edge of which (left) Gary Cooper as Dr. Wassell, medical missionary, gathers snails for use in experiment

FLASHING on the screen for a brief minute in brilliant Technicolor, a \$100,000 movie setting will bring to your neighborhood theater an authentic glimpse of the swarming waterfront of prewar Shanghai.

Careful study by Paramount researchers, backed by the painstaking work of studio set builders, provided this realistic background for a dramatic sequence in Cecil B. DeMille's production of "The Story of Dr. Wassell," which tells the heroic true-life story of the medical missionary who won world-wide fame by evacuating wounded U. S. Navy personnel from Java after the Japanese invasion.

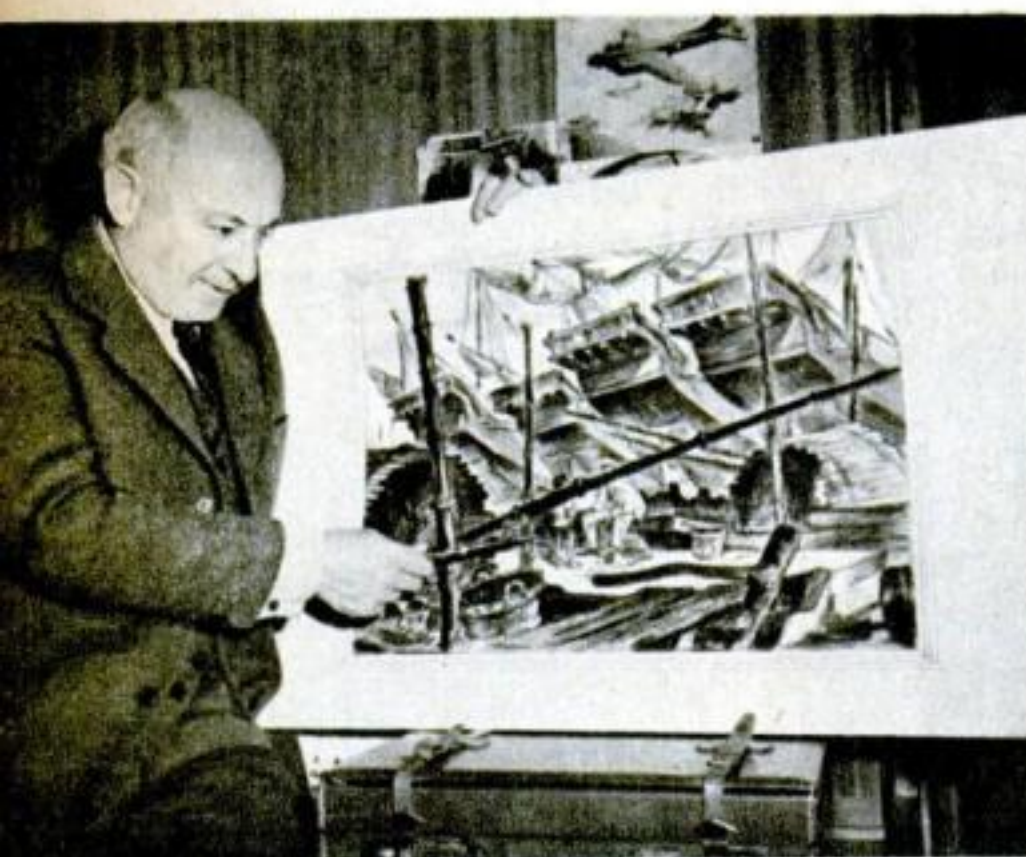
The Shanghai waterfront scene portrays an incident in Dr. Wassell's search for the intermediate host of the Oriental disease *schistosomiasis japonica*. It shows him, with a Chinese assistant, fishing from a

Shanghai Comes to Hollywood

Studio artists and builders re-create the teeming scene of an Oriental waterfront in a \$100,000 setting that will show a minute on the screen.



FIDELITY OF DETAIL in the waterfront scene required the closest study by the research department of hundreds of photographs from books, newspapers, magazines, and movie files, plus reference to scores of books



canal the snails in whose livers he expected to find the answer to his problem.

Authentic as to mood, and built with a definite dramatic purpose, the set truly represents a Chinese waterfront, with a canal in the foreground and the Yangtze in the back. Getting the details right, involving much laborious research and aid by architects and artists, figured heavily in the total expenditure for the set. Experts who worked on it included Marion Crist, research director for the producer, and Roland Anderson, art director. From the assembled pictures, DeMille planned the action, and, once the script was complete, a crude block plan was created to show the set in rough perspective. Sketches followed, showing the actors as they would look to the camera from different angles. Next a plan was drawn, marking key action throughout. An architect and draftsman projected the final sketch into working drawings, and a corps of carpenters erected the exotic structure. The set measured 100 x 175 feet and was a facade structure, complete except for details beyond the camera's view. Two days after it was completed, the scene had been filmed and the \$100,000 set knocked down.

PRODUCER of "The Story of Dr. Wassell," Cecil B. DeMille, looks over artist's first conception of the set. Below is shown a further sketch development of the still incomplete sequence of drawings that was found necessary before the building of the set began



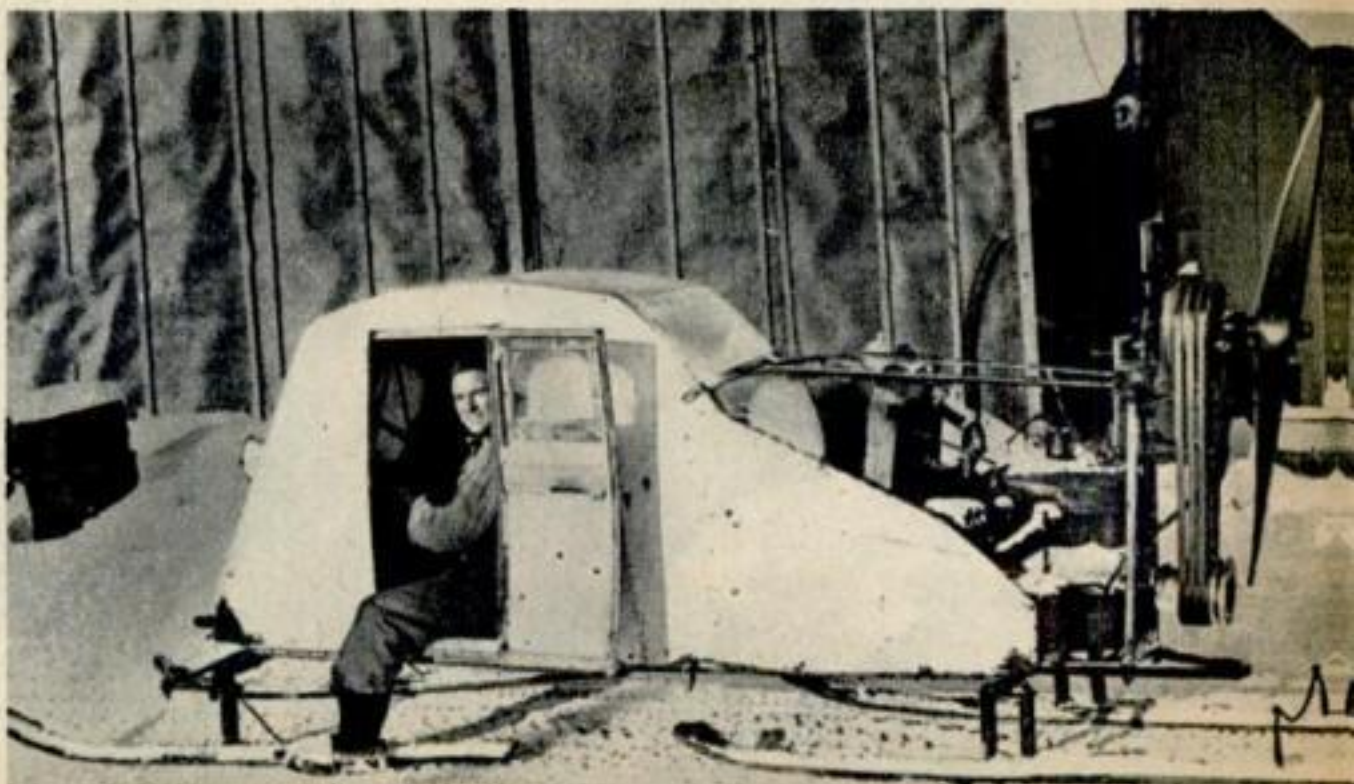
CAN YOU AT THESE PICTURES?

Have you a curious photograph showing some odd scene or happening? Send it to **POPULAR SCIENCE!** We will pay \$5 for any photo used in this department.

WEATHER-WISE WASPS solved housing problem by building their nest on the underside of a doorway electric-light reflector. When they began to build, the light bulb was missing, so the insects started in the socket and continued to spread outside. The picture came from Rev. John W. Baechle, Collegeville, Ind.



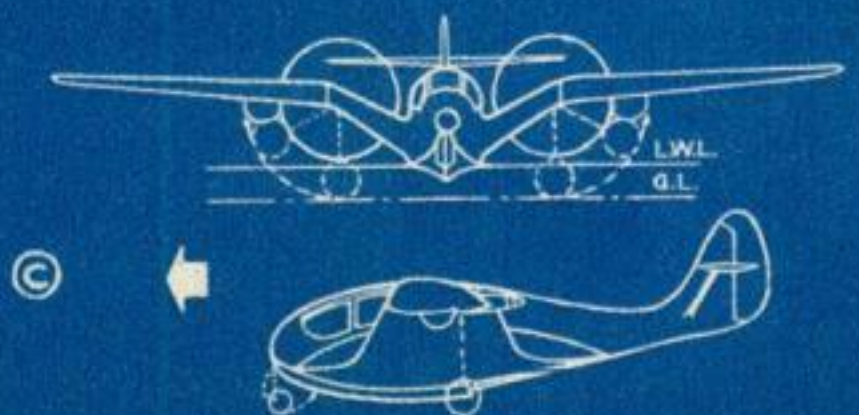
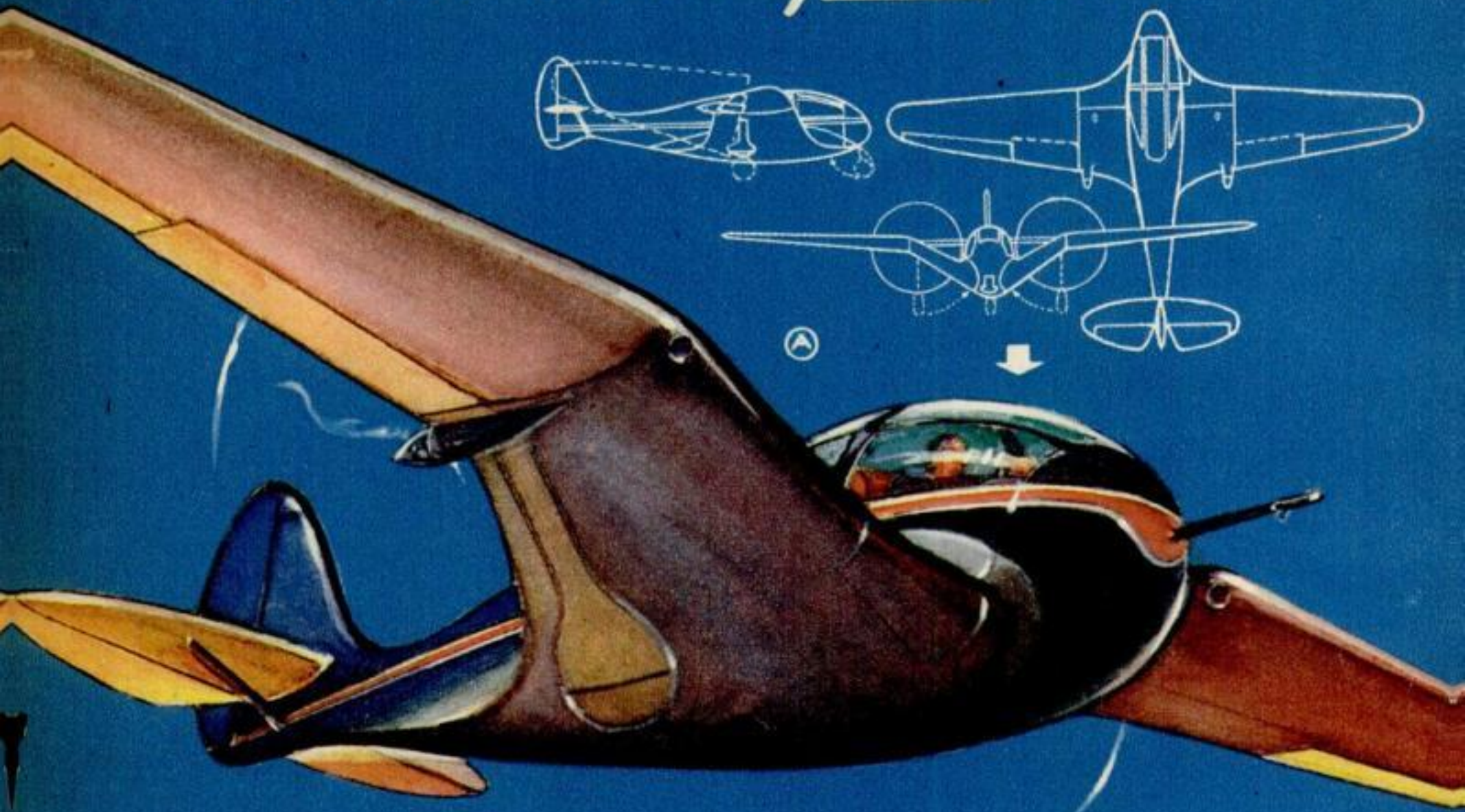
A SKI-MOBILE assembled from spare parts by Sgt. George T. Smith has proved its worth for short runs over flat, snow-covered ground. Mounted on ski-like runners, the body is cozily equipped for cold-weather driving. On a platform behind is a well-braced gasoline engine that is connected by a transmission belt with a propeller of the kind that is used on light planes.



SHE HANGS UPSIDE DOWN with the greatest of ease, this graceful young girl with the beautiful knees. Her stunt, which would set almost anyone reeling, is accomplished by means of a magnetized ceiling. The girl Dixie Rischke's a skater of fame, whose calling is dangerous (just like her name). She glides in the Icecapades show for a living. Robert Boyd, of Milwaukee, made the shot we are giving.

DOUGLAS ROLFE'S IDEAS FOR
PRIVATE PLANES OF THE FUTURE

What Are Your Ideas?



DOUGLAS
ROLFE

\$5,000 CONTEST

"The Plane You'd Like to Own"

All you have to do is write a letter describing what you think the postwar air flivver should be like . . . Everyone has a chance to win one of the many War Bond awards . . . There's a separate advanced class, too, for aviation experts.

AWARDS TOTAL \$5,000 IN TWO SEPARATE CLASSES

PROFESSIONAL

*For Aviation Engineers, Designers,
Draftsmen*

FIRST PRIZE . . . \$1,000 War Bond
SECOND PRIZE . . . 500 War Bond
THIRD PRIZE . . . 300 in War Bonds
FOURTH PRIZE . . . 200 in War Bonds
FIFTH PRIZE . . . 100 War Bond
SIXTH PRIZE . . . 50 War Bond
SEVENTH to
TWENTIETH PRIZES
\$25 War Bond each . 350 in War Bonds

NONPROFESSIONAL

*For
General Readers*

FIRST PRIZE . . . \$1,000 War Bond
SECOND PRIZE . . . 500 War Bond
THIRD PRIZE . . . 300 in War Bonds
FOURTH PRIZE . . . 200 in War Bonds
FIFTH PRIZE . . . 100 War Bond
SIXTH PRIZE . . . 50 War Bond
SEVENTH to
TWENTIETH PRIZES
\$25 War Bond each . 350 in War Bonds

IF YOU intend to try for one of the prizes in our new \$5,000 contest on "The Plane You'd Like to Own," you will be interested in knowing who is going to pass upon your ideas. The Board of Judges will consist of Edward S. Evans, Lt. Col. Earle L. Johnson, Lt. Col. Leon B. Lent, Oliver Parks, William B. Stout, and two staff editors of POPULAR SCIENCE MONTHLY. Turn to page 109 to see who these men are and the exceptional background of experience they bring to the work of deciding which entries deserve the War Bonds we are giving to encourage readers to write down their thoughts about the private plane of the future.

A board of this caliber gives you com-

plete assurance of two things that are important in any national competition: First, the complete impartiality of the judges. Second, their ability to appraise each entry for its real worth.

You can be reassured, too, on a third point. The judges will not be misled by the pretty appearance or glib wording of entries that are not basically sound. They will consider only the value of the ideas themselves. They will strike through the wording of your letter, no matter how awkward, and the meaning of your sketches, no matter how rough, to the creative thought you have put into your entry.

The principal requirement of the contest

DOUGLAS ROLFE, a well-known aviation artist, presents two views of a two-seater model and one of a four-seater amphibian (at bottom). Landing wheels of the latter are perfect spheres that double as floats, or sponsons, for rough-water taxiing. On both planes, the wings are folding and a single engine drives the propellers by shafts within the wings. The construction is plastic throughout and all instruments are included. Visibility is excellent and gull wings provide ample stability in spite of the short span

is merely that you make your ideas plain for the judges.

In the nonprofessional class, a letter of not more than 1,000 words is sufficient. If you wish—and if sketching comes easy to you—you may add some drawings to make clear any facts about the plane you cannot cover adequately in your letter. Remember that sketches are entirely optional in this division of the contest.

If you are entering the professional class, however, you are expected to submit, not only a letter, but also a three-view drawing of the plane you describe. While we do not ask that the draftsmanship be of a high order, and while it is unnecessary even to ink in the drawings, they should show clearly the information commonly given on the standard small assembly views of airplanes such as are constantly published in this magazine. *(Continued on page 109)*

TYPE OF DESIGN AND CONSTRUCTION

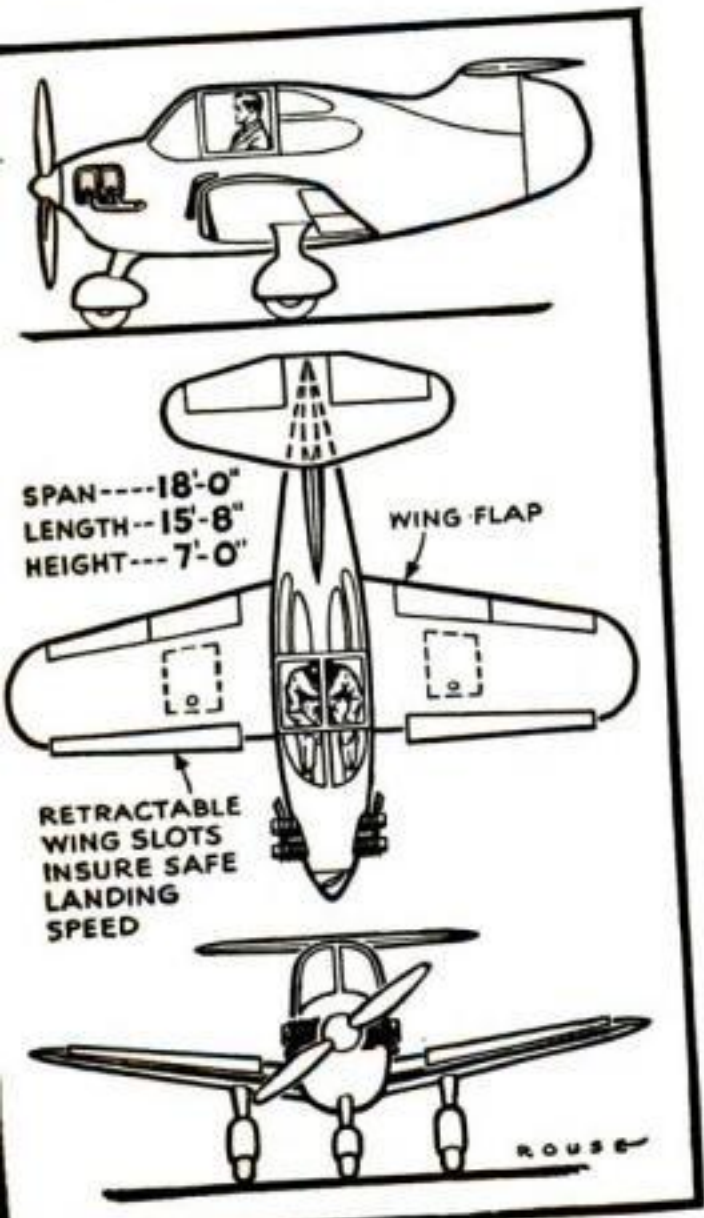
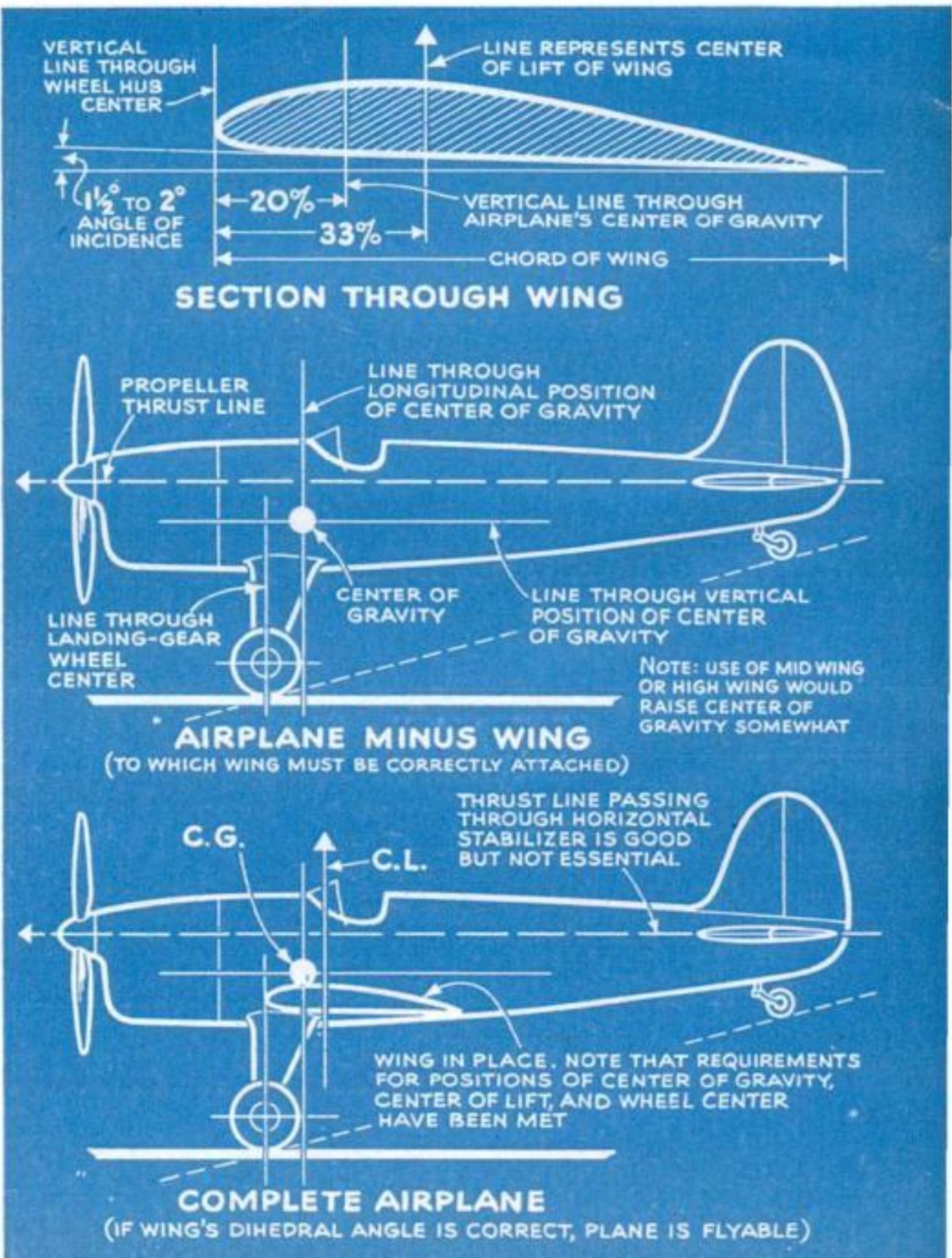
High wing, midwing, low wing, flying wing, open cockpit, cabin model, sea-plane, flying boat, land plane, amphibian, helicopter, Autogiro, tailless, roadable with removable wings, plastic, all metal, tandem seating or side-by-side, number of places, nonspinning with single control system, glider-plane combination, biplane, triplane.

WINGS

Tapered, folding, removable, gull, back staggered, swept back, rounded, pointed, square, flying wing, with flaps, spoilers, slots, trim tabs, wingtip ailerons, cantilever or strut braced, laminar flow, circular or disk variable camber, telescoping.

THESE ABC'S OF PLANE DESIGN WILL HELP

Irrespective of the type of plane you may have in mind, there are a few basic rules that must be carefully observed if your ship is to have proper stability. These rules are demonstrated in the diagrams at the right, a few of which have been exaggerated for the sake of clarity. Take the "section through wing" diagram, for instance. The type of wing that is used will, of course, determine the center of lift and also the plane's center of gravity. This diagram, nevertheless, will aid you in designing this part of your ship. Check the unusual design below for good observance of stability rules



ENGINE OR POWER PLANT

In-line, radial, liquid cooled, air cooled, gasoline, Diesel, jet, inverted, submerged in wing, pancake.

LANDING GEAR

Fixed or retracting, tricycle, wheel and skid, standard, automatic or manually retracting, with wheel pants, pontoons, amphibious, skis, wing-tip floats or wheels, wide track between wheels, self-rotating tires, blowout-proof tires, retracting tail wheel, emergency tail skid for tricycle gear.

PROPELLERS

Single blade, double blade, triple blade, folding blade, variable pitch, automatic pitch, pusher, tractor, driven from shaft, above or below cabin, screened or open, wood, metal, plastic, with or without spinner, disconnecting in case plane is roadable with folding or removable wings.

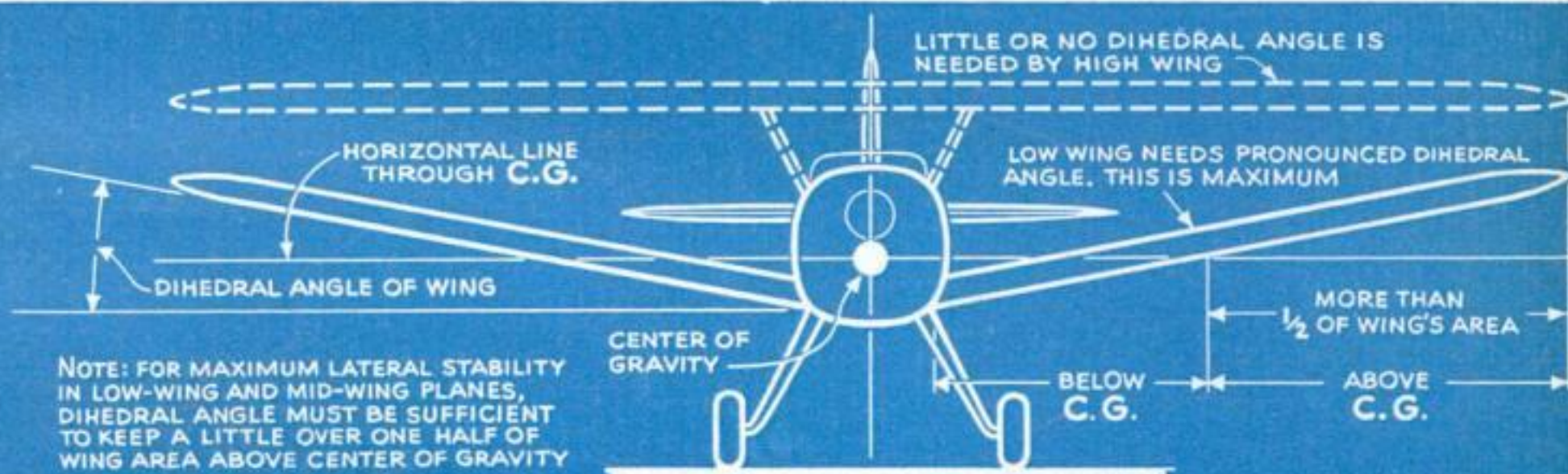
EQUIPMENT

Two-way radio or receiver only, self-starter, trim tabs, parking brakes, steerable nose wheel, dual controls, glove compartment, dome light, roof window, polaroid glass, windshield wiper, ventilation, heater, fire extinguisher for engine, de-icers, luggage compartment, sunshades, soundproofing, standard instruments plus new ones, mudguards, safety belts, emergency doors, dual instruments, rear-view mirror, adjustable seats, bulging windows for vertical vision, floor windows and wing windows for low-wing plane, landing lights, flares for emergency night landings, built-in tie-down equipment for landings in country fields, door locks, crank-down windows in doors.

TAIL DESIGN

Single rudder, double rudder, fixed rudder, retracting tail wheel, combination rudder and elevator in "V" design.

YOU PLAN "THE PLANE YOU'D LIKE TO OWN"

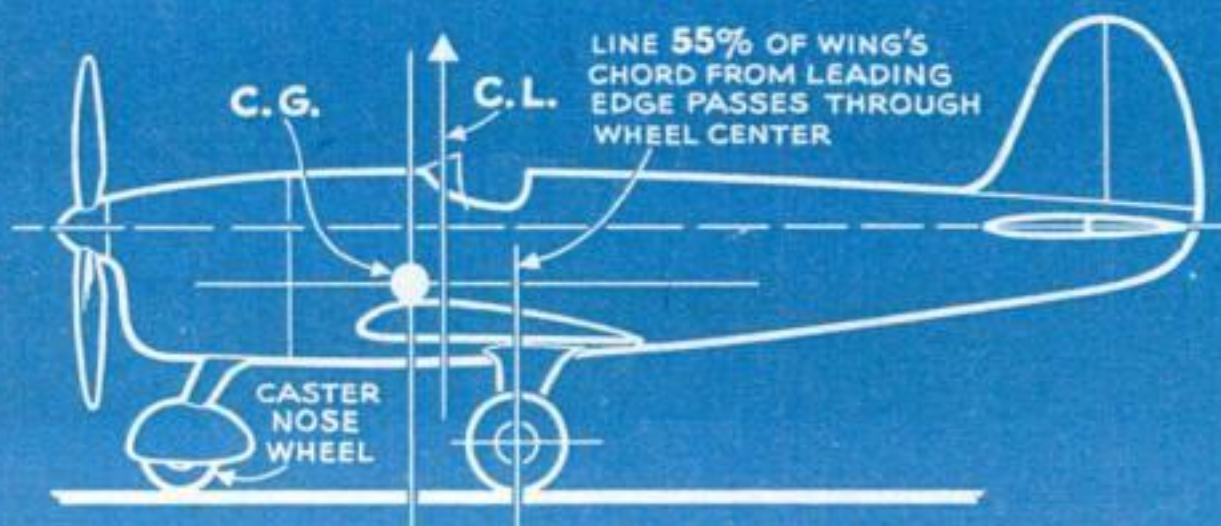


ADJUSTING DIHEDRAL ANGLE FOR STABILITY



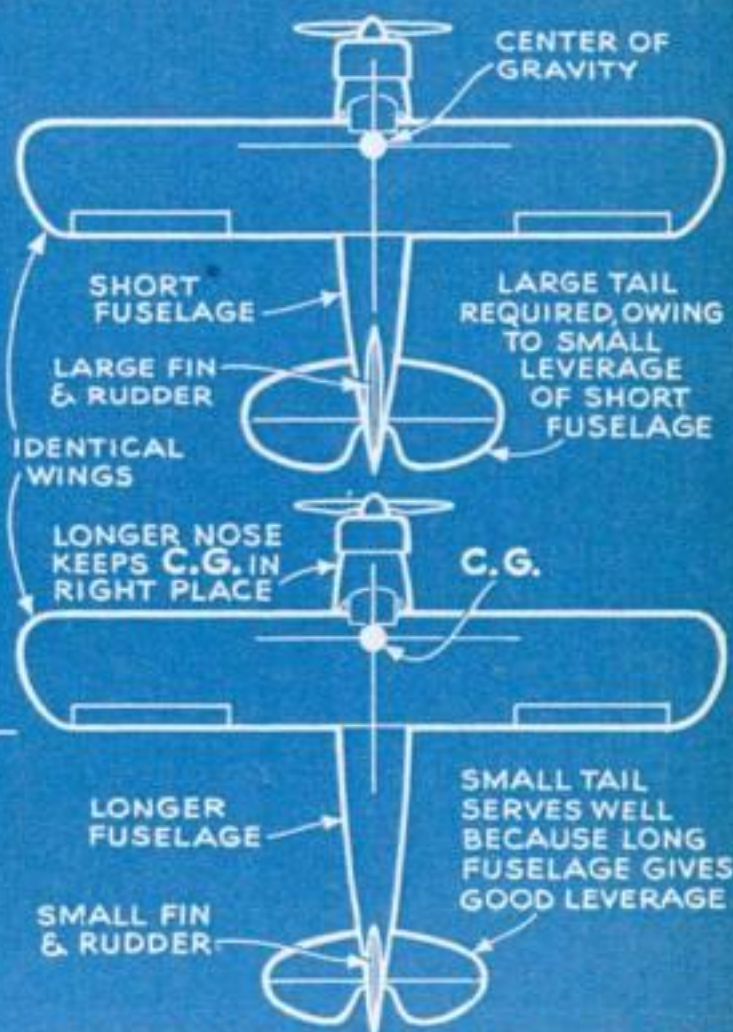
DIRECTIONAL STABILITY

(OBTAINED BY CORRECT DISPOSITION OF FIN AREA IN RELATION TO THE CENTER OF GRAVITY)



TRICYCLE LANDING GEAR

(SHORTER LANDING GEAR, BECAUSE WHEELS ARE FARTHER BACK)



FUSELAGE LENGTH & TAIL AREA AFFECT LONGITUDINAL STABILITY

Rules

THE purpose of this contest is to encourage interest in aviation in general and aircraft design in particular through serious consideration of America's private planes of the future. For the purpose of this contest the helicopter may be regarded as a private plane.

Contestants will submit their ideas as to the appearance, size, equipment, and performance of the private plane that would find the greatest postwar market among the thousands of prospective pilot-owners.

The contest is open to all except employees of Popular Science Publishing Co., Inc., and their families. Entries will be divided into two classes: The professional class will be open to those who have had training, or who are now receiving training, in aviation engineering, aircraft design, or aircraft drafting, or who are now employed or have had experience in any of these three types of work. The nonprofessional class will be open to all others. Members of the nonprofessional class may submit entries in the professional class if they wish, but professionals will be limited to the professional category. Only one entry may be submitted by a contestant. Identical prizes will be awarded in both classes.

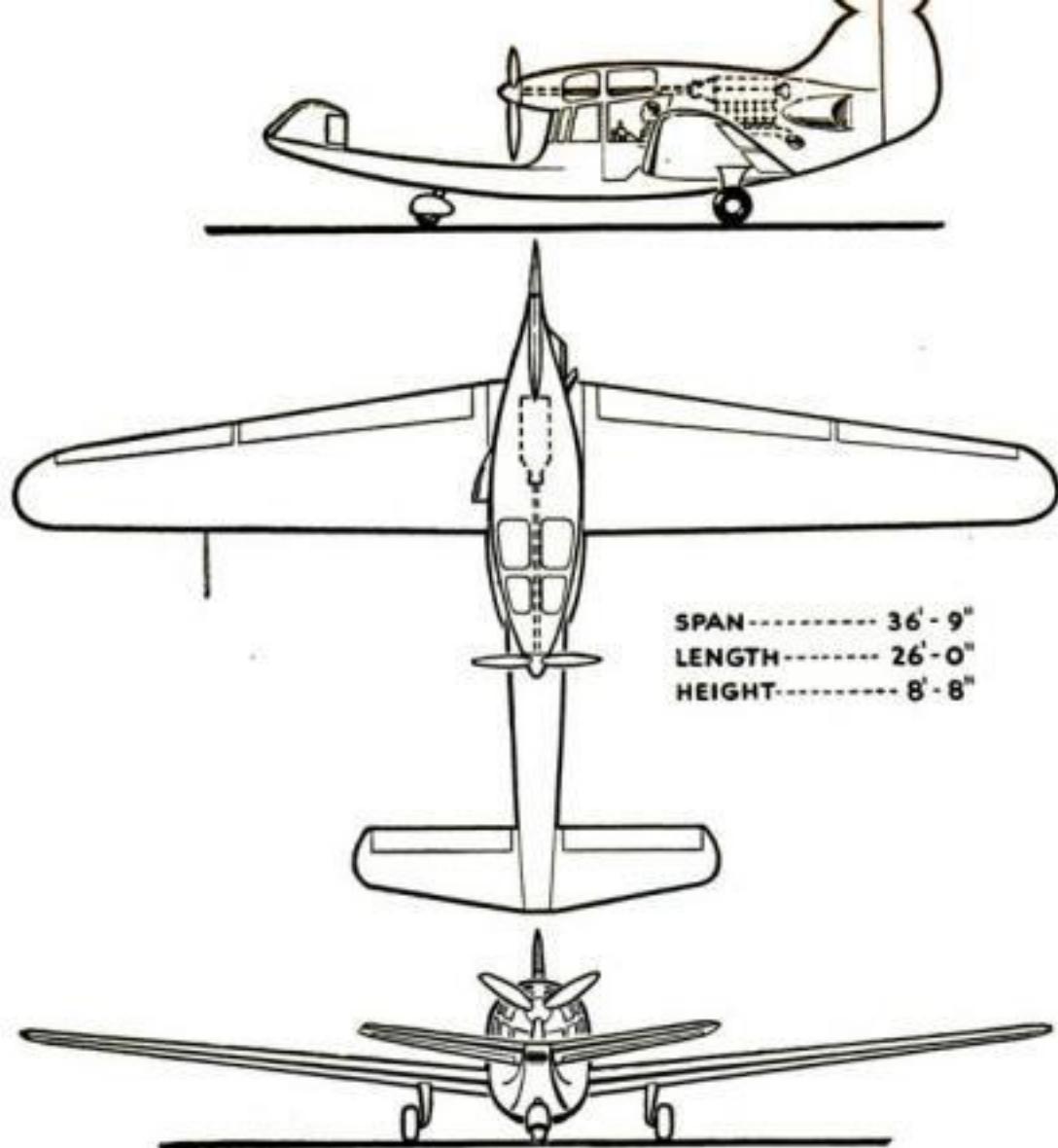
Professional-class entries will consist of at least a "three-view" drawing (front, top, and side elevations) of the proposed future private plane plus a descriptive letter of not more than 1,000 words about the plane and its theoretical performance, dimensions, equipment, and so forth.

Nonprofessional entries will consist of a letter of not more than 1,000 words describing the proposed plane. If desired, you may include a sketch or drawing of the plane in pencil or other medium.

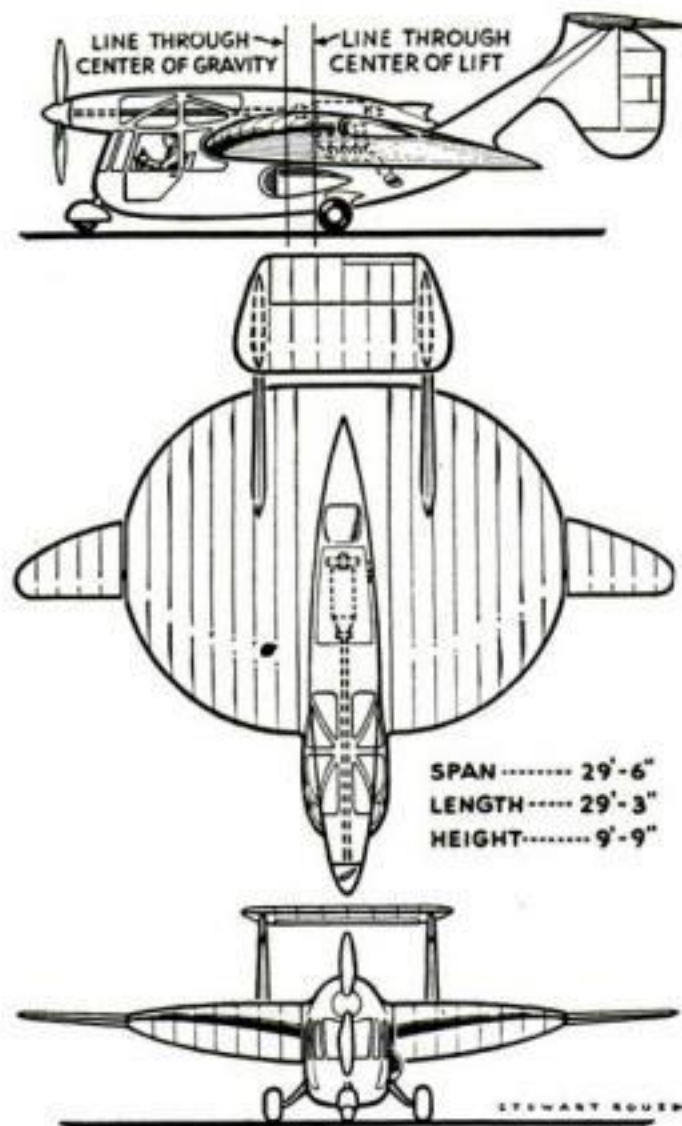
Entries will not be judged upon writing ability, craftsmanship, or decorative appearance. Only the soundness, practicability, originality, and merit of the ideas will count. Nonprofessional entries must be accompanied by a signed statement that the contestant has never been employed in, has not had training in, and is not now receiving training in aviation engineering, aircraft design, or aircraft drafting.

Entries should be mailed flat and must be fully prepaid. Each entry must be plainly marked with your name and address and the class in which the material is to be entered. (Please typewrite or print this information on each item or page of your entry.) Also state your occupation and the position held. Address Plane Contest Editor, Popular Science Monthly, 353 Fourth Ave., New York 10, N.Y. The contest will close Saturday, September 30, 1944, and all entries must be postmarked on or before that date.

All prize-winning entries will become the property of *Popular Science Monthly* for publication. However, contestants will retain the right to make any commercial use of their designs they wish. No entries will



In the "tail-first" model above are many interesting points of design. The engine is above and behind the cabin and drives the "prop" by a long shaft above the passengers' heads. The elevators have unusual dihedral for stability, and rudder area is large to offset effect of extended tail area ahead of center of gravity



Much is claimed for flight characteristics of this unorthodox circular wing. In this type of adaptation, the ailerons extend from the rims of the wings and resemble those of the early Bowlus sailplanes in which Colonel Lindbergh learned to soar. Double rudders make up for mass ahead of the center of gravity

be returned, so make a copy of your entry or have it photostated if you want to keep it for future reference.

The board of judges consists of five prominent aviation authorities who are widely recognized as outstanding leaders in their individual fields, and two editors of *Popular Science Monthly*. The decision of the judges will be final. In case of ties, the tying contestants will receive identical awards. All contestants will be informed by mail as to the winners as soon after their selection as possible.

To help you to clarify your ideas, we are presenting certain basic information. This month we give you some ABC's of aircraft design so that you may be sure your plane will be theoretically airworthy—stable and flyable. In addition, we are including some suggestions for three unorthodox types of planes, in case you believe that the private plane of the future will tend in the direction of the unconventional rather than follow the line already laid out by the light planes of the present.

These ideas supplement the many practical suggestions for contestants which we published last month. If you missed the June issue, it will pay you to look up a copy and study particularly the interchangeable airplane elements shown in the drawings.

In next month's contest article, the helicopter will be discussed. Other service aids for contestants will include the correct nomenclature for various types of airplane construction, parts, and design details.

In addition, we are showing a few full-color paintings of small planes designed by artists who specialize in aviation drawings. Last month there was a page of ideas by Eric Sloane; this month the artist is Douglas Rolfe; next month Stewart Rouse will give his ideas for two postwar planes. These full-color pages are presented merely to encourage you to strike out along original lines yourself. They are not entries in the contest and, in fact, the judges would not consider drawings of this pictorial type unless accompanied by a written description as required in the rules.

Whatever you do, be sure to read the rules on page 108 very carefully. Note particularly that your entry must be marked with the class in which it is to be considered (professional or nonprofessional). See that it bears your full name and address, and that every sheet has that information. Send it in as soon as it is ready, but in no case mail it later than September 30, 1944. Only entries postmarked on or before that date will be considered.

In order to assure the maximum effi-

Here is a tailless private plane that passed the drawing-board stage before the outbreak of war. A "pusher" type, it has five vertical rudders and an elaborate set of flaps, ailerons, and tabs on wings' trailing edges

Judges

WILLIAM B. STOUT

Manager, Stout Research Division
Consolidated Vultee Aircraft Corp.

OLIVER PARKS

President, Parks Air College

EDWARD S. EVANS

President, Evans Products Co.

LT. COL. EARLE L. JOHNSON, AAF

National Commander U. S. Civil Air Patrol

LT. COL. LEON B. LENT, AAF

Head Engineer, National Inventors Council

ARTHUR WAKELING

Assistant Editor, Popular Science Monthly

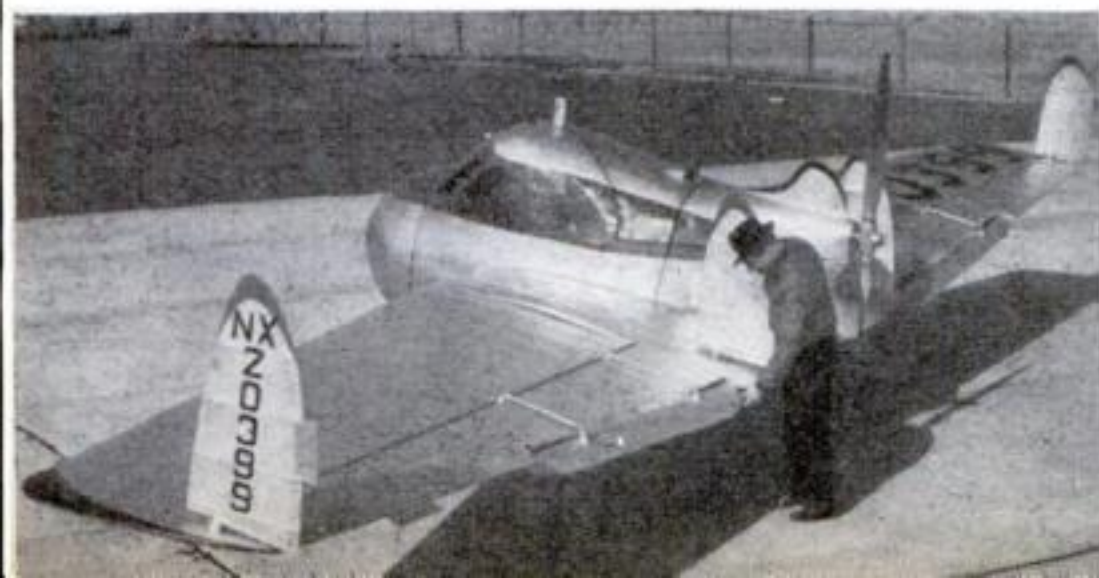
C. B. COLBY

Aviation Editor, Popular Science Monthly

ciency in conducting the competition, POPULAR SCIENCE MONTHLY has organized a large group of distinguished experts who will constitute the Contest Committee. This body, the members of which will be announced next month, is entirely distinct from the Board of Judges. The committee will serve in an advisory capacity in the conduct of the contest, but will not participate in the final evaluation of the entries and the distribution of awards.

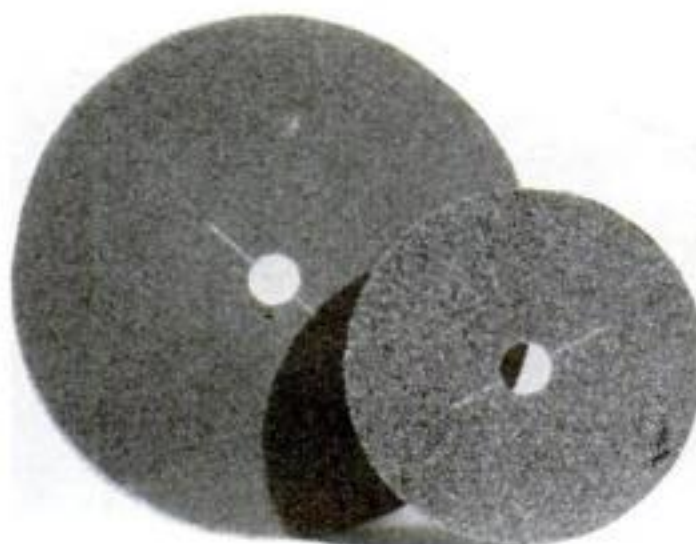
The selection of members of both the Contest Committee and the Board of Judges has been governed by one thought—to make the competition one in which every reader will have an equal chance to win. The rules have been drawn up with the same intention. Now it is up to you. Get out your pencil and a scratch pad, if you haven't started already, and jot down your ideas on the plane you'd like to own. You'll enjoy the thrill of planning something new for the coming days of peace. It'll be stimulating and profitable—win or lose.

Because of its versatility, many feel that the amphibian is the ideal private plane. On this model, motor is high above the reach of any spray. The tail has been raised to keep elevators and rudder well above the water

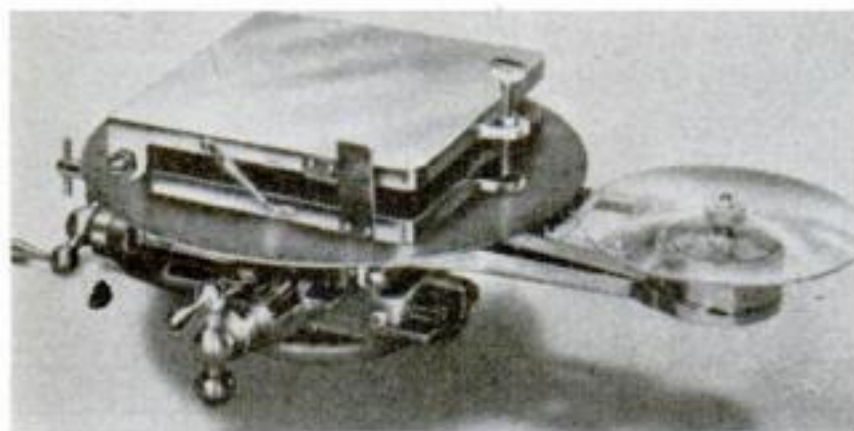
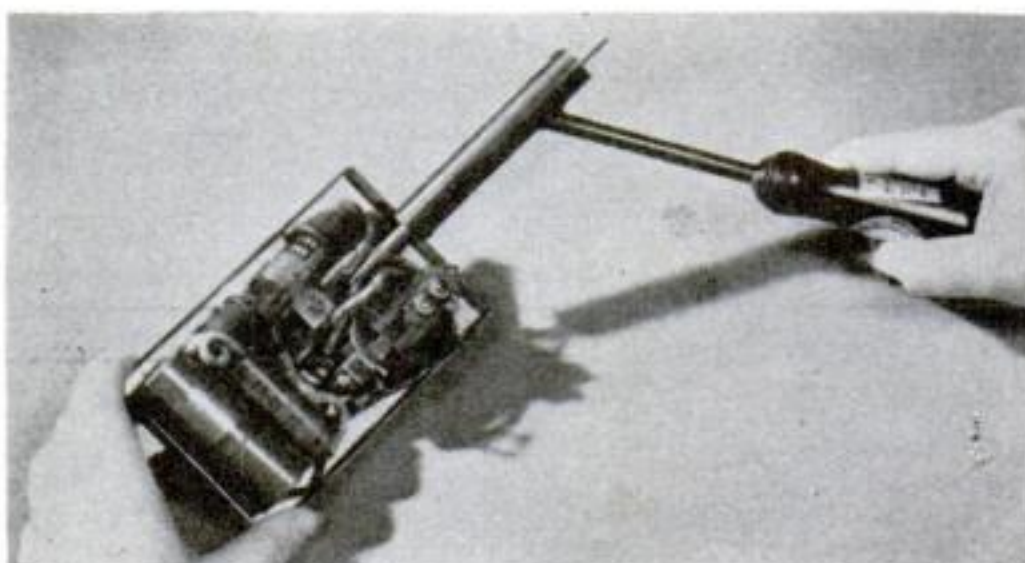




ABRASIVE DISKS of Metalite Fibre Combination are made up of aluminum oxide grains and cotton drill glued to a vulcanized fiber. They are used for polishing metal surfaces before covering them with paint or lacquer, and are effective for removing hard enamel coatings as well as lighter metal finishes. Made by Behr-Manning, Troy, N. Y.



ANGLE-HEAD soldering iron goes places and does things that are difficult with the ordinary type. In a tight spot, its extendable tip, running through the center of the barrel, permits the user to solder electrical connections without burning the insulation on adjacent wires. The scientifically balanced angle-head lessens fatigue by allowing the operator to hold the iron with ease. It is made by the Kelnor Manufacturing Co., San Francisco.



PRECISION-CUT CRYSTALS used in radio, sound-detecting, and locating devices are given extreme accuracy by the Clark Replacement Orientation Table, which is said to eliminate the necessity for much of the expert manpower formerly required for making corrections. The table is adaptable to any quartz-cutting saw, and is designed to minimize wear from vibration.

METAL-SHRINKING process, ordinarily tedious, is speeded and simplified by a compact, portable, hand-operated machine made by C-B Tool Company, Lancaster, Pa. This shrinker handles metals .016 to .051 inch thick, shrinks angles to a three-inch radius, and will work angle stock up to one inch wide. There is a combined stretching and shrinking process involved in bending angle stock, for the outside of the curve must of necessity be longer than the inside. The device weighs 12 pounds.



Can you identify These War Wagons?

They're in the news; they're making history; they're helping to win the greatest war. Can you name them as they roll by? Try to identify them, and then check your answers with the list given at the bottom of the page.



1. "Alligator" amphibian tank. 2. "Duck" amphibian truck. 3. Quarter-ton truck and cargo truck. 4. M-10 tank destroyer. 5. 75-mm. tank destroyer. 6. Personnel carrier (jeep). 7. Light tank, M-5. 8. "General Sherman" medium tank, M-4.

Like Destroyers

They're no luxury liners, these vicious ship-killers. Their men crave action—and get it. Here's a true sea yarn of deadly battle in bomb-churned Pacific waters.

By WILLIAM HEALD GROVERMAN

Commander, U.S.N.

IN ALL the history of sea warfare no type of craft has had as stormy and active a career as the destroyer. It is the Navy's jack-of-all-trades, a hunter-killer with an amazing degree of versatility. Theoretically, the life of a destroyer in a close-range torpedo attack on enemy ships of the line is about three and a half minutes. Actually, it proves out to be more than that, but the risk factor involved will convey a general idea of the kind of fighting a destroyer engages in.

I want to relate here some of the work

that our destroyers have done in this war, including the fighting in the Battle of Kula Gulf, and in so doing to salute the crews of our destroyer squadrons.

It was my privilege to serve on destroyers for more than a year in the South Pacific, first as executive officer under one of the finest destroyer men afloat, then as commander of my own ship. In that period it was touch-and-go with Japanese surface craft, submarines, and aircraft. I am giving away no secrets when I say that for a time we fought uphill. The Japs had us outnumbered. We had to outfight them, and we did. The erosion of Jap naval strength is testimony to that.

The destroyer gets its name from the fact that it packs torpedoes. The torpedo is the most potent weapon that any navy has. It is every destroyer man's ambition to make a torpedo attack on the enemy. It is the essence of excitement because, to be effective, such an attack must be launched within minimum range of the heavy-ship targets. That puts the destroyer under the fire of both the main and secondary batteries of the big fellows. A destroyer has no protective armor. So it must depend on its own armament, speed, and maneuverability to stay afloat.

The destroyer came into its own for the first time in World War I. Refinement of the torpedo made torpedo fire really effective for the first time in sea warfare. Perhaps the most daring light-force attack in sea history, up to now, was the one ordered by Admiral Scheer at Jutland when, to protect his ships of the line, he sent his destroyers, battle cruisers, and light cruisers against the British Grand Fleet. The British were about to execute the classic "T" maneuver, and desperate measures were called for. It is reasonable to assume that if the British had not turned away, the destroyers would have delivered some damaging torpedo blows. It also has been said that the British forfeited a golden opportunity to destroy the German fleet. That poses a question no one can answer.

One of Uncle Sam's destroyers, tough and effective for in-fighting, lets go with a burst of antiaircraft fire against a night attack by Japanese bombers during an attempted landing by the enemy on Vella Lavella Island in the Solomons group





The U.S.S. *Radford*, commissioned in July 1942, is one of the reasons why Commander Groverman likes destroyers. Her record as a hard-hitting battler in the South Pacific is matched by the stamina of the officers and men who have fought on her

Some men do not like destroyers. They are rough vessels at sea. They are "wet boats." Their shortness and narrow beam give them a high roll-and-pitch movement in heavy weather. Even in a smooth sea, there is movement to the ship. The quarters of the officers and the men look, to a man accustomed to larger boats, like miniatures of the real thing. In plying the North Atlantic, destroyer crews are exposed to the worst of the elements. The ships come into port covered with ice.

Yet destroyer people consider their vessels more seaworthy than larger ships. A destroyer conforms to the convolutions of the sea, while bigger vessels are like lighthouses or breakwaters, receiving the full impact of the waves. A destroyer is like a lightweight boxer who knows how to roll with a punch. To continue the simile, larger craft are like heavy-footed, durable boxers who can't avoid a punch but can take it.

Incidentally, the worst enemy of the destroyer crews in the South Pacific is the Japs. The worst enemy of those in the North Atlantic is the weather.

The destroyer *Radford*, which was destined to write its name in bold letters into the annals of World War II, was commissioned in July 1942. It was one of the first of the *Fletcher* class, of 2,100 tons. That compared with 1,650 tons for the previous class and 1,200 tons for the old four-stackers of World War I. The *Radford* had (and has, for she is still in there fighting) a complement of 21 officers and about 300 men, almost three times that of the destroyers laid down a quarter of a century before. She was constructed in the yards of the Federal Shipbuilding Company in Kearny, N. J.

The officers and men sent to commission a new destroyer usually are destroyer veterans. That's a nice feature. The commanding officer and executive officer know a large percentage of the nucleus of the crew by name. That was the case with the



FRESH from the vicious in-fighting of the South Pacific, Commander William Heald Groverman, author of this article, late in February reported for duty on the staff of Commander Destroyers Atlantic Fleet. He stood the strain for about three days.

"I want to go back to combat sea duty," he said bluntly to his superior.

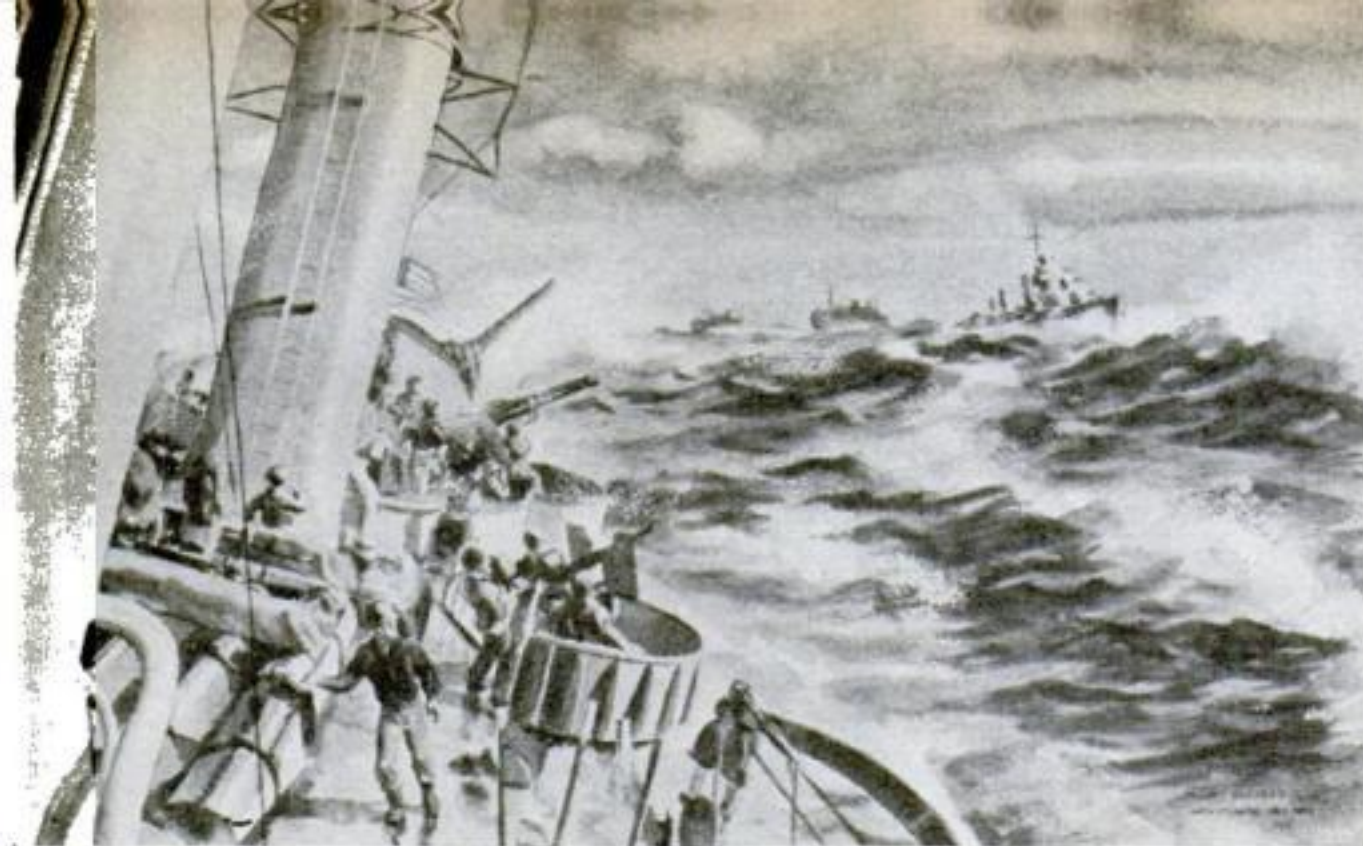
"Hell," was the rejoinder. "So do I." Groverman stayed.

His exploits as the executive officer of one destroyer and as the captain of another won him the Silver Star and the Gold Star. He also wears the rarely given Unit Citation Ribbon awarded the crew of the U.S.S. *Radford* and four bronze stars on his Pacific Campaign Ribbon for participation in campaigns and specific actions.

A Kentuckian, he was graduated from the U. S. Naval Academy in 1932.

Radford. On that day at the New York Navy Yard, Commander William K. Romoser became her captain. I had the good luck to become her executive officer.

We liked destroyers for many reasons. High among them was the fact that, owing to the smallness of the craft, there is relatively little pomp and ceremony. The discipline is just as strict as it is on a battleship, but the men work together more intimately. When the time comes to dress up, a destroyer sailor dons his best because he



Destroyers are rough vessels in a heavy seaway, as this water color done by Lt. Dwight Shepler, U.S.N.R., indicates. The picture shows the U.S.S. Champlin, escort to a troop convoy, tracking some unidentified aircraft

is proud of his ship and of his own appearance, not because the captain tells him to. I believe there is more *esprit de corps* in a destroyer's crew than in that of any other type of vessel afloat.

To a destroyer man, the *Radford* looked more like a light cruiser. She was trim, very seaworthy, and packed a hitting power far superior to that of previous classes. She was the result of the latest in engineering, ordnance, and hull design. We felt that she had been born without "bugs," that she would be able to fight without the continual alterations that are normal in new-class vessels. Experience with her bore this out.

She had two stacks. Her deck was flush, extending all the way from the foc'sle to the fantail. She handled better than any destroyer I'd ever known. She was easy to maneuver and reacted instantly to the helm. The living quarters were conventional. The captain ate in the wardroom with his officers, instead of in his own quarters as in larger vessels. That put him into closer contact with his men.

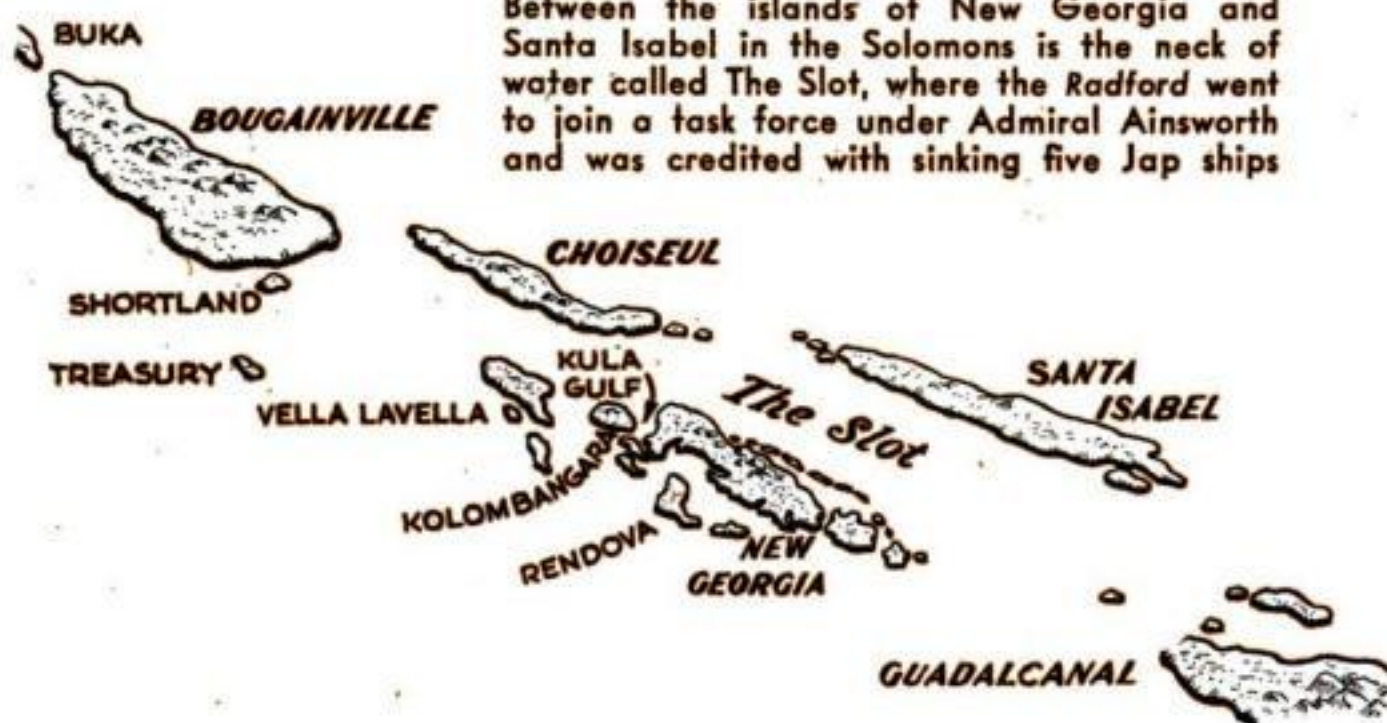
We went through a regular training period in the Atlantic, spotting the characteristics of the men, determining whether we had any trouble-makers in this small world encompassed by the bulkheads. One seaman did make some trouble for us. He was ordered before a summary court-martial and drew a bad-conduct discharge. But before the Judge Advocate General's approval of the BCD came through, the *Radford*

was in operation in the Pacific war zone. In the meantime something had happened to the man that will be described in a moment.

We shook the *Radford* down and became satisfied that she would make a good showing when the time came.

Toward the end of 1942, we let her prow feel the warmth of South Pacific waters. Immediately upon arrival, we were assigned to a "hunter-killer" group, commanded by Capt. R. P. Briscoe and later by Capt. F. X. McInerney, both old destroyer men. We headed for the Guadalcanal area to operate against the "Tokyo Express." This was a group of Japanese ships, usually destroyers, that was reinforcing Jap garrisons on Guadalcanal.

The Japanese continually dealt us night air attacks, so it was customary for the ships to spend the day obtaining fuel, ammunition, and provisions, and the night under way. It was a rugged life. It got extremely hot during the daytime, the men were at general [\(Continued on page 196\)](#)





Ready for Anything

**CIVILIAN-DEFENSE RESCUE TRUCK
CAN FEED VICTIMS, QUELL RIOTS**

By **FRANK ROWSOME, Jr.**

Drawing by **B. G. SEIELSTAD**

DESIGNED for disaster—that's the slogan of this elaborately equipped light-duty rescue truck. Planned, fitted out, and manned by volunteers, it stands ready in Corona, N. Y., for almost any imaginable trouble, from train wreck to bombing, trolley smash-up to civil disturbance.

Most large U. S. cities have regular (that is, heavy-duty) rescue trucks, usually assigned to the police or fire services, which are packed with such equipment as pulmotors and oxyacetylene cutting torches. Nevertheless, bulky, costly tools and expensive motorized transport are things that a smaller community won't often require, and often can't afford. For the small city or

Equipped for rescue work, ambulance duty, riot control, and feeding refugees, this truck was lent for the duration to Civilian Defense Council, Corona, N. Y.

good-sized town, a light rescue truck fills a vital need. Its value is the greater because it can do jobs that ordinary rescue trucks can't.

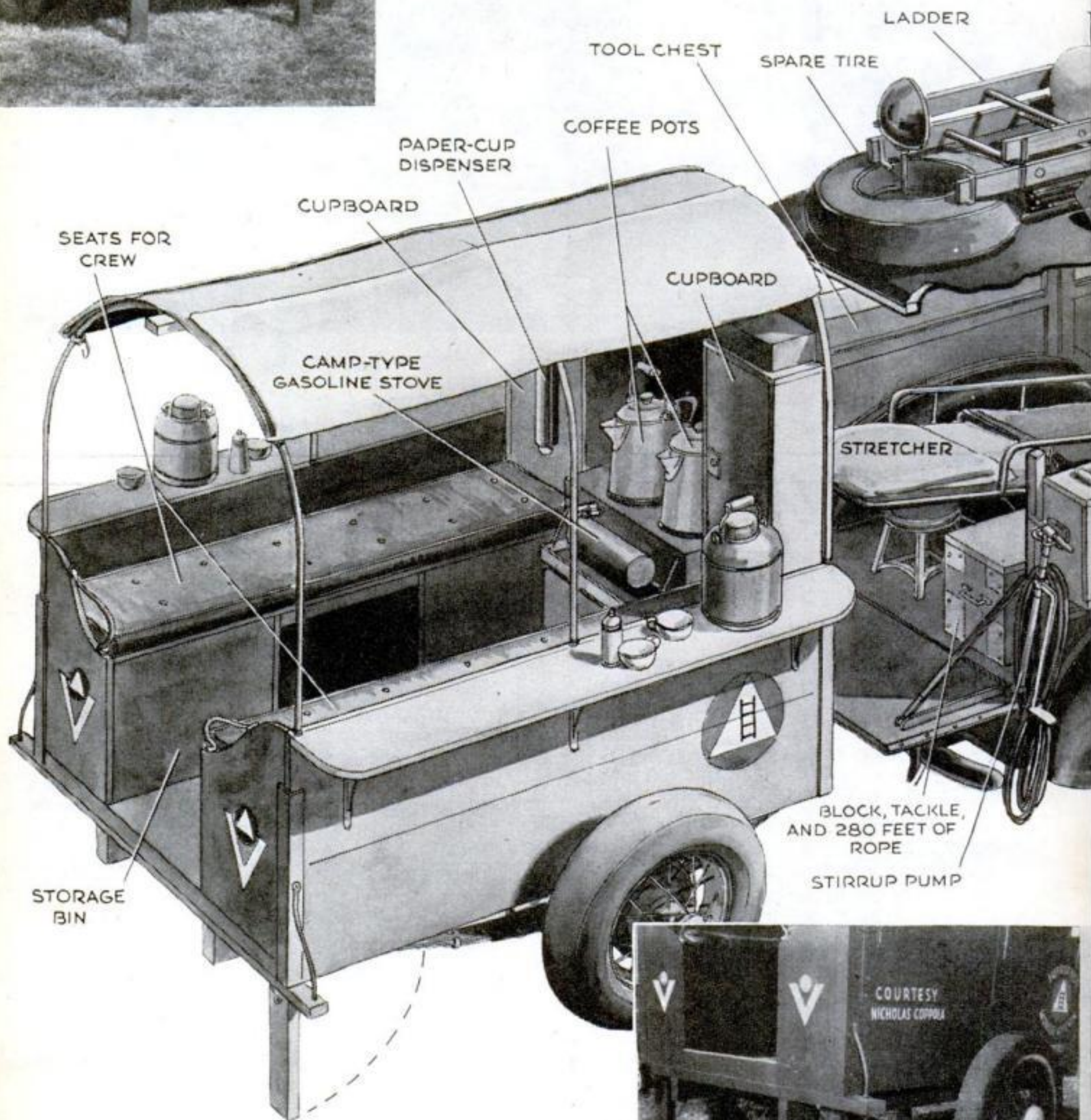
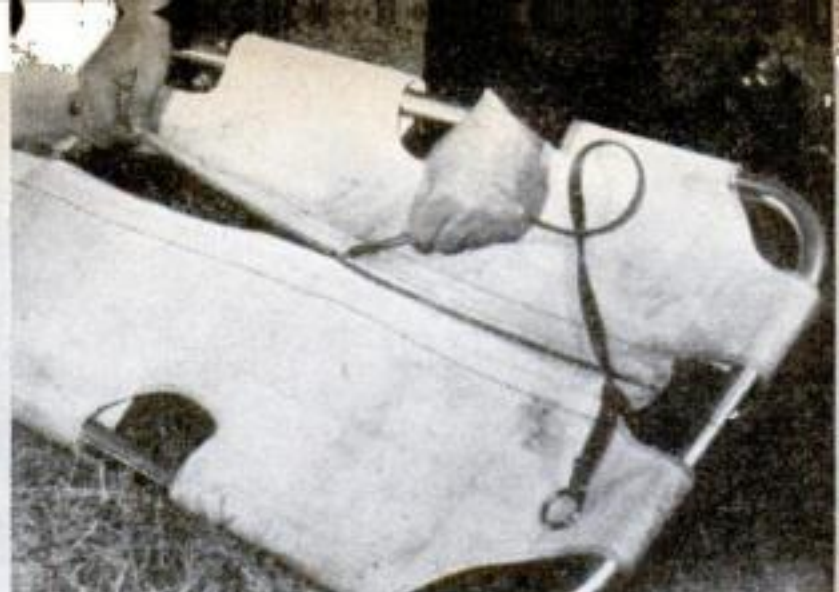
For example, the Corona truck is cleverly planned for three other functions besides its primary job of extricating the victims of explosions, accidents, and the like. A two-wheel trailer serves as a mobile kitchen, fully equipped to give the prompt mass feeding that is frequently an important part of disaster service. In addition, it carries full first-aid supplies and can if necessary be speedily turned into an ambulance. Thirdly, the truck can also serve as a riot-control car; a pair of powerful amplifiers can be hooked up to either a record turntable or a microphone to aid in giving directions to crowds or warning the dwellers in an imperiled area.

Originally a late-model station wagon, the rescue truck had to be modified a bit to fit its new job. Extra leaves were added to the springs to take the normal load of $1\frac{1}{2}$ tons. A heavy-duty generator and a second battery were installed to carry increased elec-

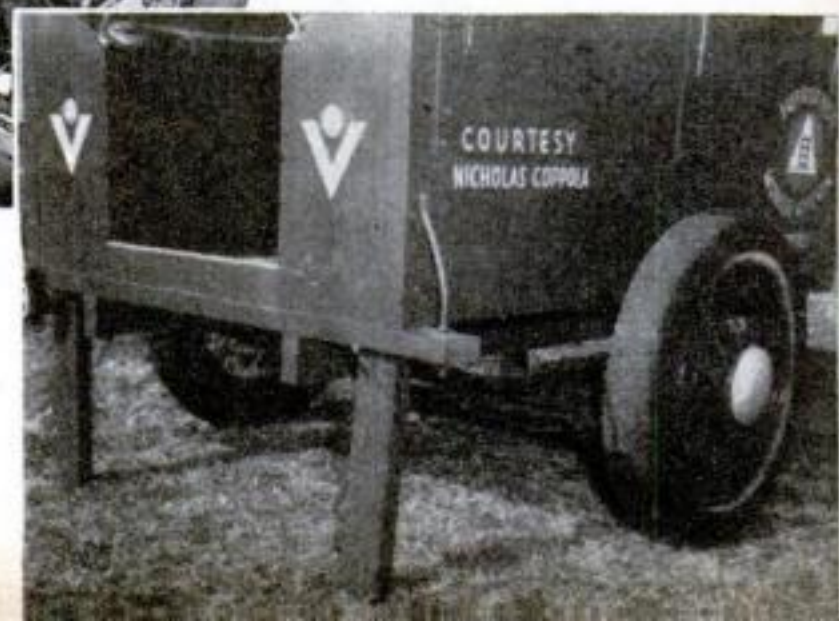


Trailer, shown at left, is mobile kitchen that is equipped to serve coffee and sandwiches to large numbers at the scene of a disaster

An important item of equipment is "broken back" stretcher for cases needing special care



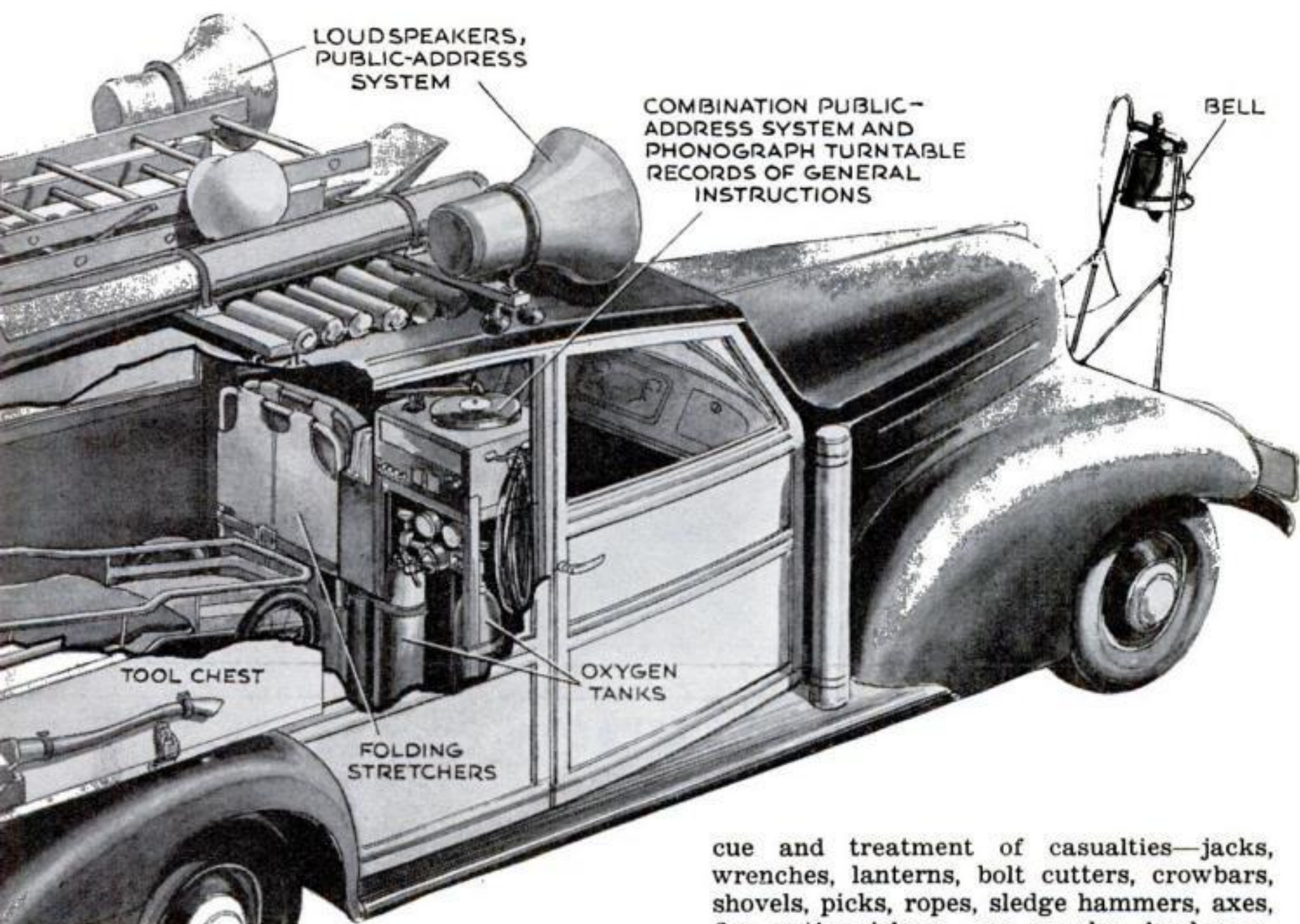
When unhitched from the truck, the trailer is made to stand alone by letting down a retractable leg located at each corner





With this stretcher, an injured person can be transferred to bed or operating table by separating socketed ends and withdrawing canvas from under patient

The barrow-type stretcher, right, has a pneumatic rubber mattress, pillow, sheet, besides two wool blankets



trical load. The entire electrical system was rewired, and a heavy fire bell was mounted on a pipe frame in front of the radiator. The trailer was built from the front end of a light car; it can be swung into position by one man, and it has four folding legs.

Completely stowed about the truck is a vast array of equipment to aid in the res-

cue and treatment of casualties—jacks, wrenches, lanterns, bolt cutters, crowbars, shovels, picks, ropes, sledge hammers, axes, fire extinguishers, gas masks, hacksaws, goggles, rubber and asbestos gloves, cold chisels, block and tackle, bandages, splints, tourniquets, and the like. Most of the more essential tools are duplicated, and all are located so that they can be reached in jigtime.

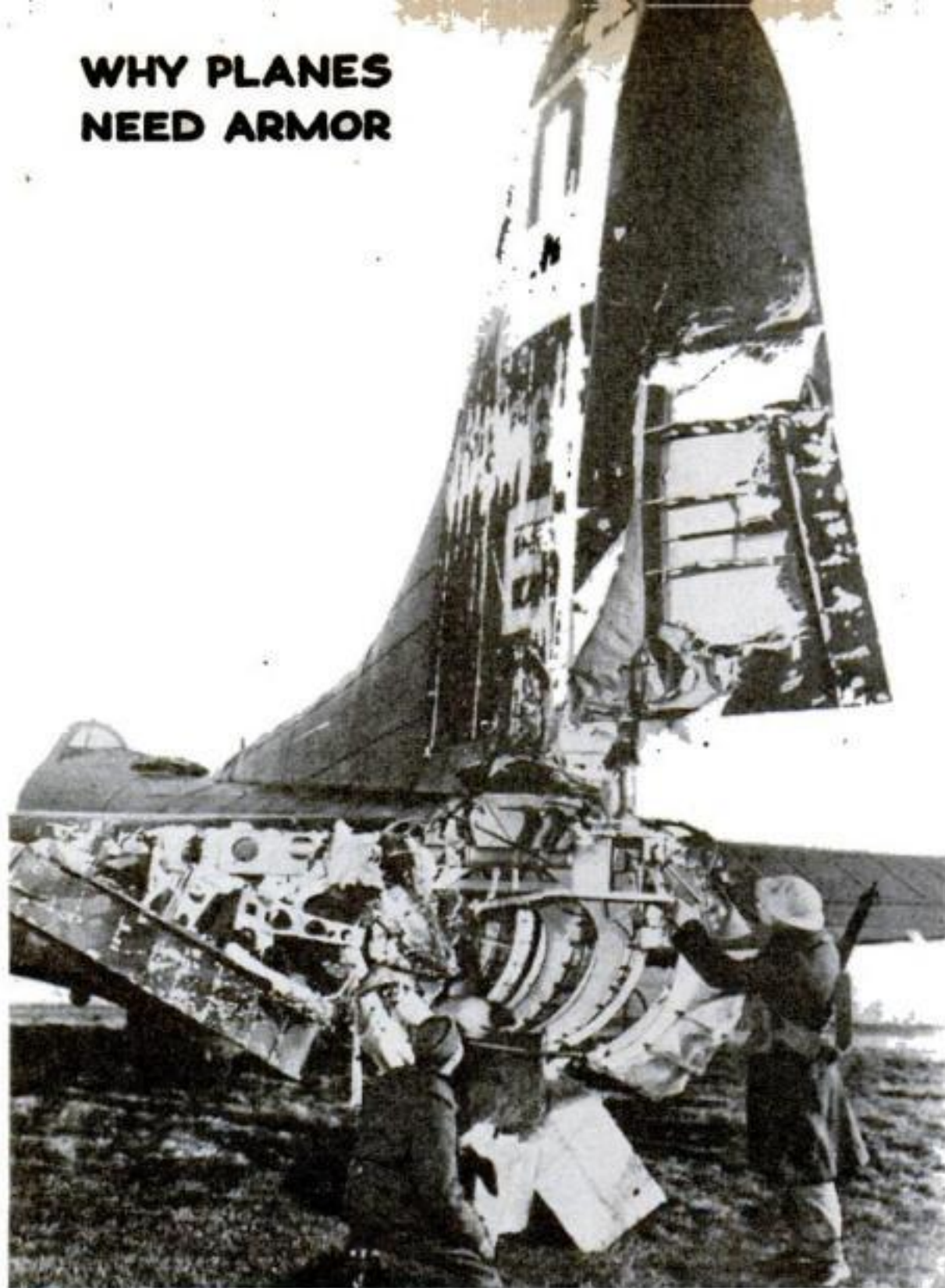


Large stores of tools are mounted in the removable boxes (left) on the sides of the truck

Loudspeakers aid in riot control, the evacuation of an area around a time bomb, and warning citizens to take cover



WHY PLANES NEED ARMOR



Yankee pilots brought this Flying Fortress back to the bomber base in England in spite of the terrific punishment she took over Germany. The tail assembly was full of gaping holes and the rear gunner's compartment missing

machine guns designed to penetrate the bomber's protective armor. This same bomber, on the other hand, is provided with armor designed to stop or deflect the bullets of these hard-hitting weapons. As a result of this aerial ring-around-a-rosy, the use of armor plating is influencing gun design to a greater extent than any other single tactical consideration.

Theoretically, the ideal method of protection would involve armoring the whole airplane, in which case there would be no vulnerable spots. The weight of such a flying tank would, however, reduce performance to nil, if such a ship would fly at all. Thus, the problem of protection versus weight must be approached from other directions; and attempts at a solution of the riddle have made armoring an exacting science.

It has not always been this way. The early applications of armor protection to aircraft were strictly a matter of trial and error. During the "forgotten war" in Libya during 1911, when Italy and Turkey battled over Tripolitania, the Italians employed several kinds of French planes for reconnaissance missions. On several occasions, casual-

ties resulted from Arab rifle fire. Capt. Alessandro Guidoni, the noted pilot and scientist for whom Italy's great aeronautical research center was named, installed a heavy steel plate in the cockpit floor of a Farman biplane and, after several unhappy test flights, succeeded in placing the armor where it would not disturb the plane's flying behavior. A number of other craft also were fitted with these steel floor plates and sent into service: this is believed

Why Our Planes Can Take It

ARMOR OF STEEL, GLASS, AND EVEN PLYWOOD GUARDS MEN AND EQUIPMENT AGAINST ENEMY FIRE

By JAMES L. H. PECK

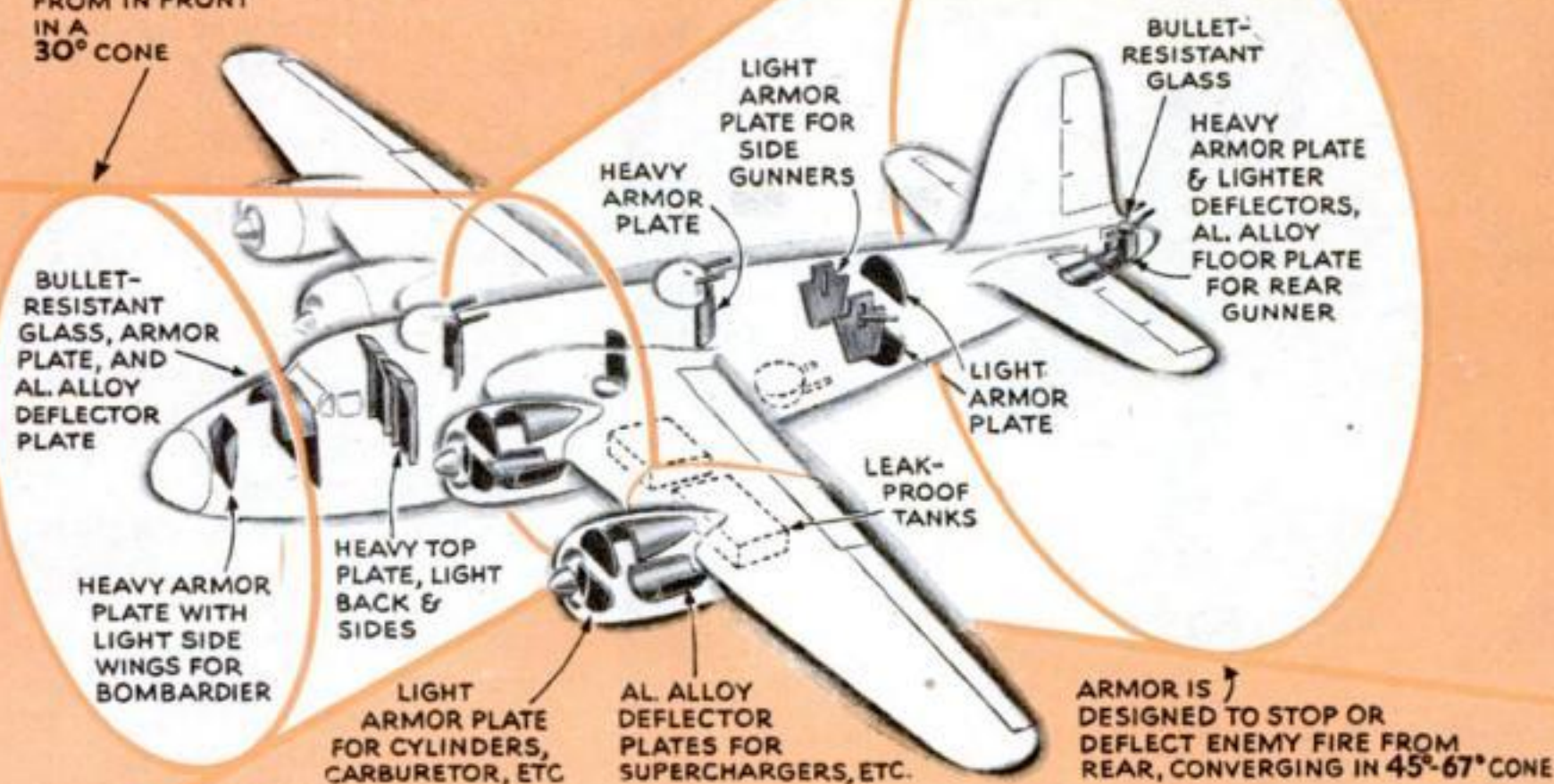
Drawings by STEWART ROUSE

THE air war's progress has produced a deadly new array of airborne weapons, and combat planes are carrying aloft not only this heavier armament but greater quantities of it. As a passive security measure against the enemy's artillery, Allied and Axis craft alike are fitted with various types of armoring that brings into use steel, glass, dural, and even plywood.

But here is a vicious circle: A fighter is armed with hard-hitting cannon and

HOW BOMBERS ARE ARMORED

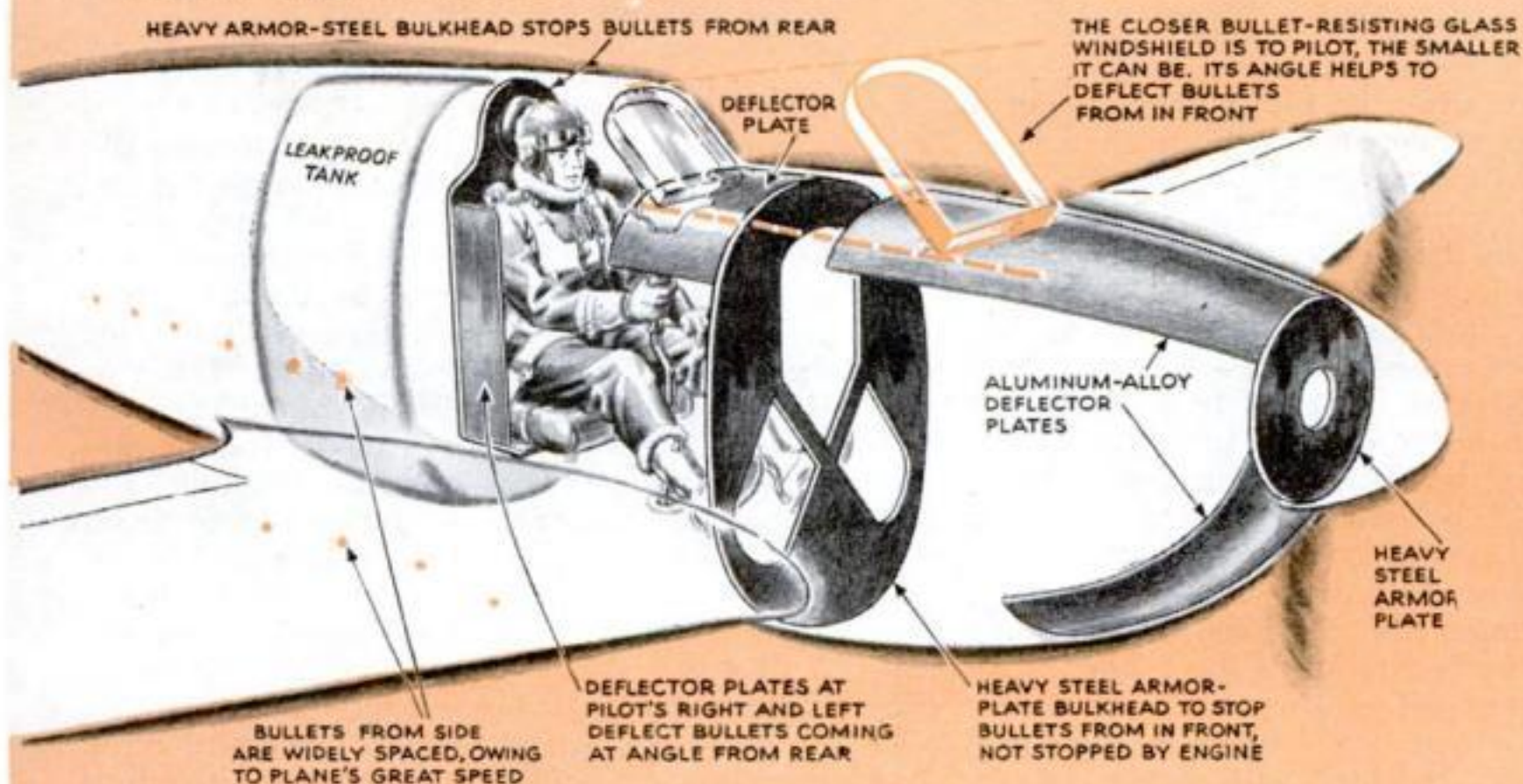
ARMOR IS DESIGNED TO STOP OR DEFLECT ENEMY FIRE CONVERGING ON BOMBER FROM IN FRONT IN A 30° CONE



ARMOR IS DESIGNED TO STOP OR DEFLECT ENEMY FIRE FROM REAR, CONVERGING IN 45°-67° CONE

HOW FIGHTERS ARE ARMORED

HEAVY ARMOR-STEEL BULKHEAD STOPS BULLETS FROM REAR



to have been the first successful employment of armored aircraft.

During World War I, airmen of both sides used various protective devices, one of the most popular of which was a stove lid which the pilot put on the seat beneath him. More enterprising flyers put other parts of the stove to use by fitting side slabs to the floors of their planes or securing these pieces of cast iron behind their seats. Perhaps the best-armored plane of that war made its appearance in 1917 in an all-metal Junkers-Fokker attack plane that was the

first specialized airplane developed for ground strafing of troops. These craft were not used in large numbers, nor were any other specific models of armored airplanes. Pilot protection, as we recognize it today, was not generally a World War I practice.

Today, armor is built into the plane. It is one of the primary considerations in early stages of design, and the fruits of such forethought have been brought home to the public in newspaper accounts. There was the Flying Fortress, for example, that returned home on a wing and a prayer after



FLAK MATS, steel plates covered with heavy duck, are laid in an overlapping pattern on the floor of a bomber to protect crew members. The men shown are also wearing the new body armor

a mission over the Philippines during which it had been peppered by more than 1,500 Jap bullets. Only two of the crew were wounded, neither seriously, but the bomber's armor was so badly pitted that new plates had to be installed.

RAF pilots have told interesting tales of how they literally emptied their guns into the Messerschmitt ME-109F's, when these were encountered for the first time over Germany, without putting the ME's out of action. The latest of these Nazi ships, the twin-engined ME-410, which came into service very recently, has successfully withstood even cannon fire. Perhaps the best-armored single-engined plane to be found in service anywhere is the Russian IL-3 Stormovik fighter-attack ship, which the Reds are able to fly at tree-top altitudes through the heaviest German flak. How these planes, among others, got that way is somewhat of a story.

While the performance of combat aircraft, whether they be small fighters or giant bombers, is greatly hindered by the amount of armoring required against 1944 firepower, the additional security to pilot and plane more than compensates for the reduction of speed, climb, and maneuverability. In adhering to their formula of "maximum protection/minimum weight," the designers continually strive toward a fair compromise between the two. By clever location of the armor plating and by the use of lighter metals and other materials, they and the ord-

nance men have been able to strike an even balance between weight and protection.

The first phase of scientific approach to the problem of decreasing weight deals with the relative vulnerability of one warplane to the gunfire of another. The ever-increasing operating speeds of aircraft influence their ability to withstand enemy gunfire; the 400-miles-per-hour fighter or the 330-miles-per-hour bomber move so swiftly, as compared with the firing rates of cannon and machine guns, that bullet holes are rarely found to be closer together than four inches. In most cases, ground-crew men in the combat theaters say, the holes are considerably farther apart than this.

Unless the pilot or a vital part of the plane is hit, the wide dispersal of bullets provides the ship with considerable resistance to gunfire, even if it is not armored at all; when the pilot's cockpit and other soft spots are armored, the ship can "take it" to an amazing degree. The speed not only disperses the hits widely, but brings about changes in the angles at which these bullets hit the rapidly moving craft. The experts can closely estimate the angles from which attack is most probable against a given type of plane, but these angles vary according to the types of craft engaged in combat. An engagement between two ships with fixed armament—such as the Mustang and the ME-109G-2—would involve considerations different from those met in combat between a ship with flexible armament and one with fixed guns—such as a Flying Fortress against a Focke-Wulf 190.

Generally speaking, on either bombers or fighters the angles of attack from which hit probability is highest approach through either the rear hemisphere—a 180-degree area extending from beneath the plane up to a point above the ship—or the forward hemisphere—the area encompassing the plane's nose. Through these angles, forward and aft, there is not the amount of deflection incident to side shots; thus the chances for hits are more favorable.

Knowing the angles from which attack is most likely and most dangerous, the ordnance men can locate the armor plating strategically. We must keep in mind that the purpose of armoring any airplane is to afford protection; and this may be accomplished as successfully when a section of plating deflects the bullet away from the

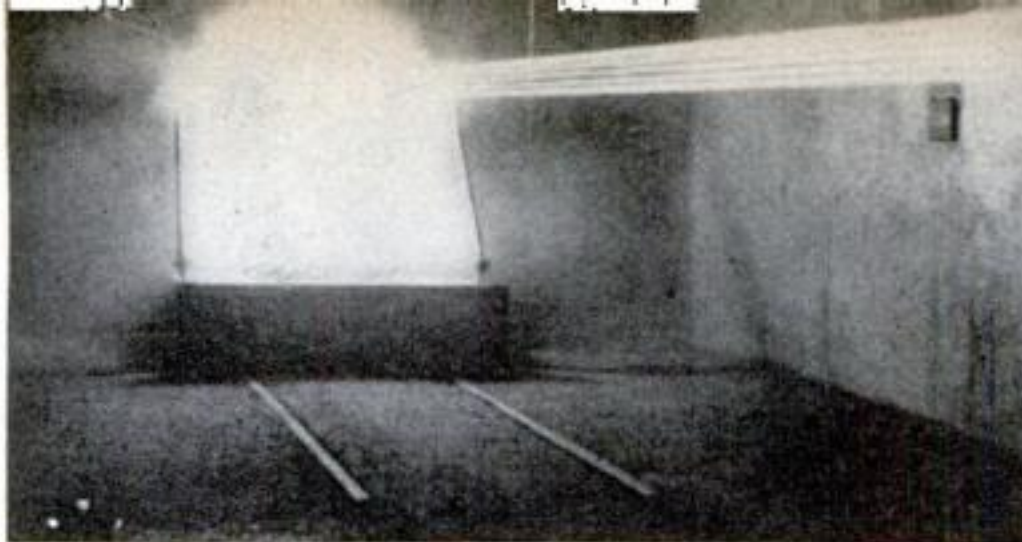
vital spot as when the armor stops the bullet dead. If placed in such a manner that bullets from likely angles of attack will hit it glancing blows at less than 45 degrees, a relatively thin sheet of plating will serve its purpose every bit as well as a thicker piece of armor placed so that bullets meet it more directly. In certain types of planes, the greater part of the armor can be installed at a slant toward the expected line of fire, permitting a relatively lighter plating to be used. In other types of craft, structural features make this impossible, and a relatively heavier plate must be used.

Another phase of this "strategic location" has to do with the pilot and air crew. In the bomber, the latest practice is to centralize within a specific area as many of the air crew as is possible, and surround this area not only with appropriate kinds of armor protection but also with as much of the ship's auxiliary equipment as the structure of the craft will permit. By centralizing, more men can be protected by less armor; a single plate may suffice for two or more of the flight crew.

The reason for centralizing the auxiliary equipment is not so obvious. A bullet, in passing through some part of the plane's structure, is sent tumbling end-over-end and distorted in shape, instead of continuing its normal spiraled flight. There are two factors to be overcome in affording resistance to a bullet: impact, resulting from the bullet's velocity, and bore effect, resulting from the high-speed rotation of the missile. When the projectile is "tumbled," the impact is reduced considerably and the bore effect is completely nullified.

The ordnance men have collaborated closely with the aircraft designers to install auxiliary equipment in such a manner that it will serve as baffles or deflectors. For example, a plane's landing wheels, in the retracted position, would slow up bullets considerably. The nose *(Continued on page 230)*

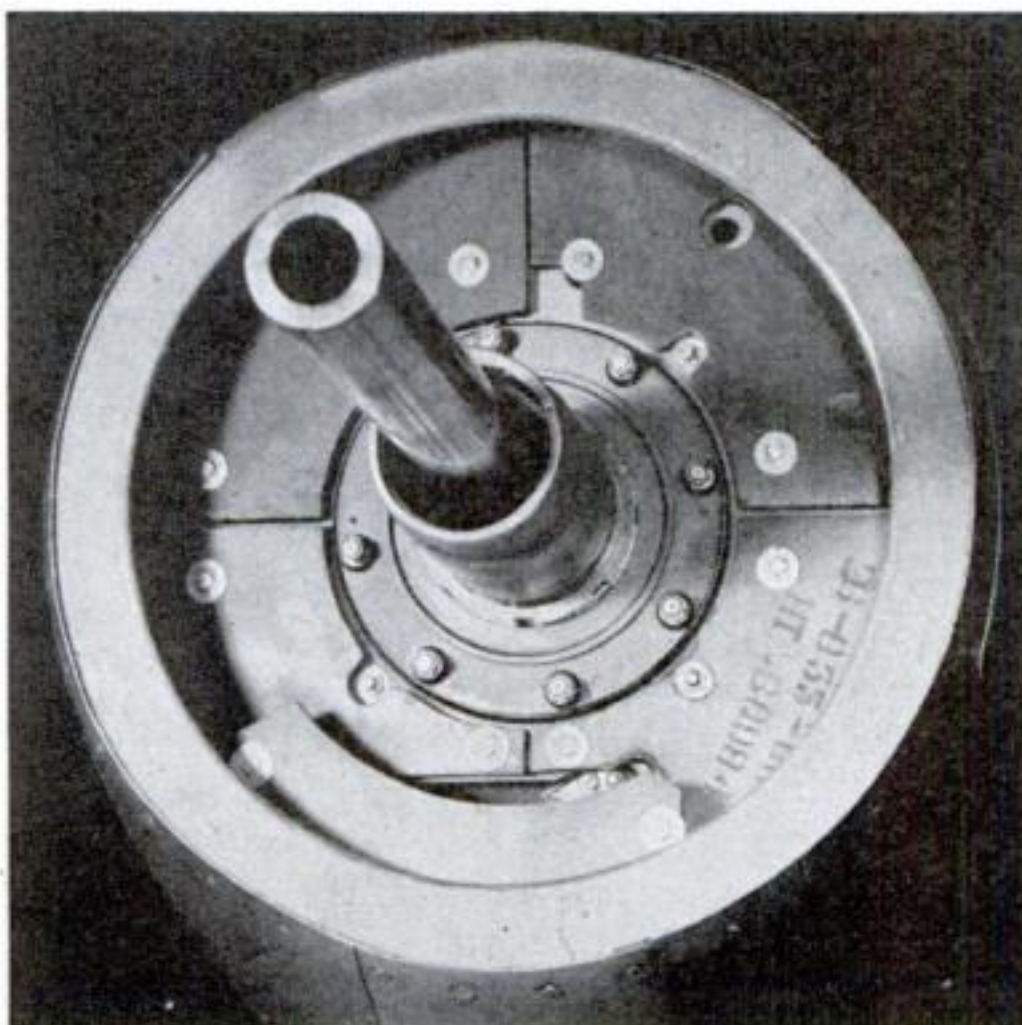
NOSE GUARD. Plates of $\frac{5}{8}$ -inch homogeneous armor plate cover the delicate reduction-gear mechanism in the prow of the P-39 Bell Airacobra fighter. The 37-mm. cannon is inside the propeller shaft



AIRPLANE ARMOR GETS THE WORKS in a test by machine-gun fire with tracer bullets. Trials are made for hardness and tensile strength of the armor and the velocity of the projectiles fired. Steel is also analyzed for chemical composition



CUT AND SHAPED to protect personnel and vital parts of the plane's equipment, the finished armor units are sprayed with paint and then hung upside down from crane hooks in the drying room of the factory to await shipment for installation



Silver Fights, Too!

Drafted from the vaults at West Point, this luxury metal is working overtime on the home front and also doing a bang-up job on the battle line in many war weapons.

By ALBERT Q. MAISEL

WHEN visiting foreign lecturers used to tell us that Americans were crazy people, they always had one pet example of super-madness to prove their case. They would point out the utter folly of our digging silver out of the mines of Butte, Mont., only to bury 70,000 tons of it in a man-made mine at West Point.

It did seem rather silly then, when our Government bought up over \$1,000,000,000 worth of silver, seven times the world's annual production, just for "useless" hoarding. But if we didn't have that hoarded silver today, this country's war production would be tied up half a hundred ways. We'd have to do without a lot of weapons that we simply can't dispense with—such as our 155-mm. fieldpiece, which uses 9½ pounds of silver for vital recoil mechanisms.

That wouldn't be the worst of it. If we didn't have our hoard of silver, we'd do without a lot of aluminum and magnesium. And we'd be more hard up for copper and tin and nickel than your wife is for meat-ration coupons.

It happened this way: Right after the fall of France, the Government got together with private industry and started to build scores of big aluminum and magnesium plants, each with row upon row of electrolytic furnaces. Each furnace required from 8,000 to 40,000 amperes of current in transforming bauxite into pure aluminum. In the old days, these heavy currents were carried on copper bus bars. But when the experts began to figure how much copper the giant new plants would need for bus bars, their hearts sank. There just wasn't that much copper available—and what copper our rushing mines did produce was needed for

shell bands, machinery, cartridges, and a thousand other war items.

Then someone—we ought to erect a statue to him—thought of the vaults at West Point!

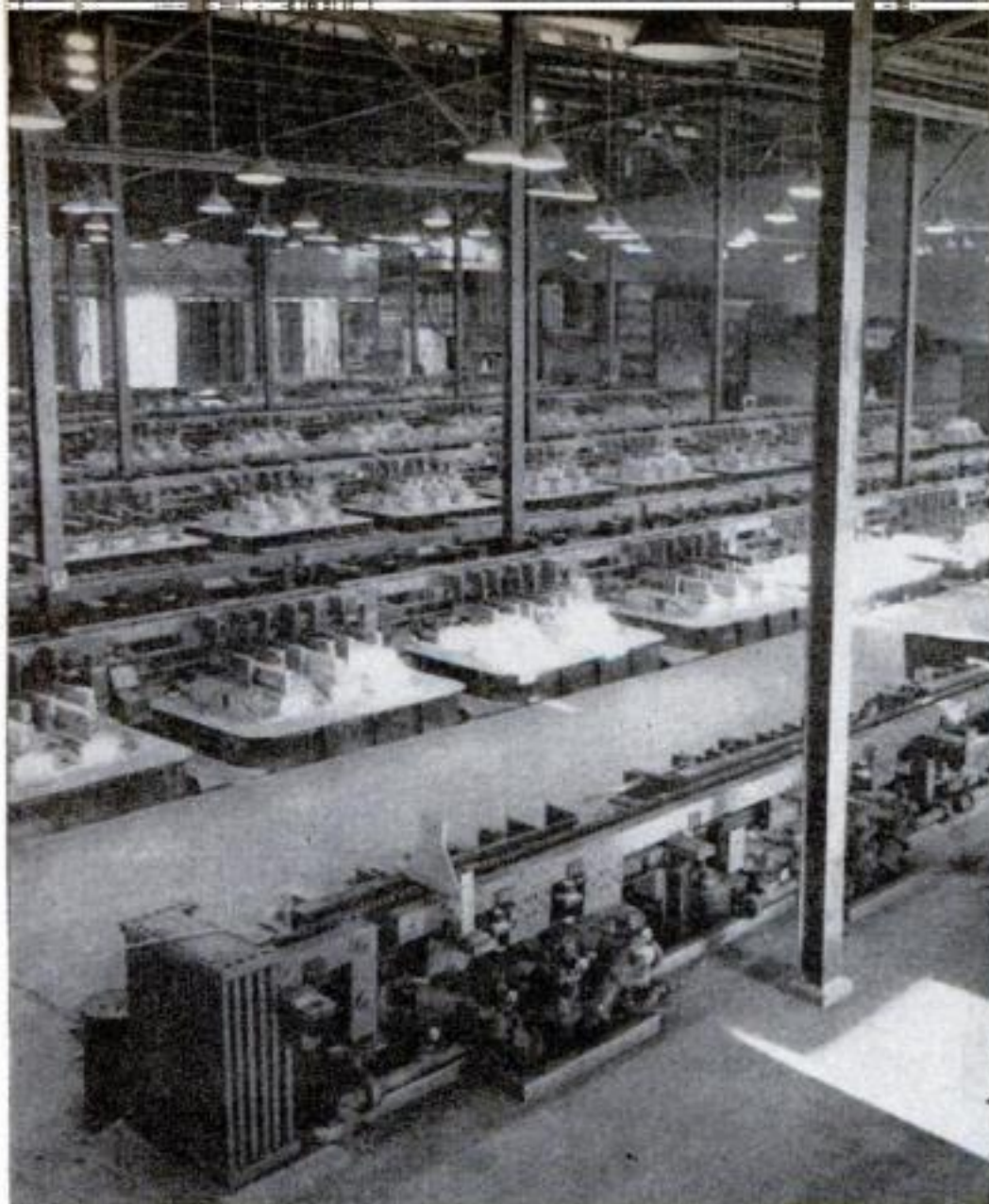
A sort of little Lend-Lease plan was organized. The Treasury Department, which owns the silver, lent its shiny bars to the Defense Plants Corporation. And presently the useless hoard began to be rolled and formed and shaped into giant bus bars. The silver has now moved, for the duration, to plants all over the country to carry current and make aluminum and magnesium. When the war is over and copper is again available, the loaned silver will be returned to the Treasury and restored to the vaults.

That's the idea, at least. But the silver is working out so well that some experts suspect that it may be used indefinitely. For silver is an even better conductor of electricity than copper; in fact it's the best of all metals. At any rate, we can thank our lucky stars that the Treasury had all that silver lying around. To date it has lent 19,000 tons of it, more than we normally consumed in industry in 15 years. And that's just one of silver's new uses.

The metal is being used on every plane we make—and on most guns, a lot of tanks and field kitchens, bombs, torpedoes, ships, parachutes, and chemical shells. For many of these uses it was first adopted as a substitute. But, somewhat to the surprise of Army engineers, it has often proved better than the metal it replaced. Take, for instance, the case of the silver-plated airplane-engine bearings. Connecting rods for radial airplane engines must stand terrific strains in transmitting the power of 100-plus octane gas from pistons to crankshaft and propeller. All stress is concentrated on the surface of



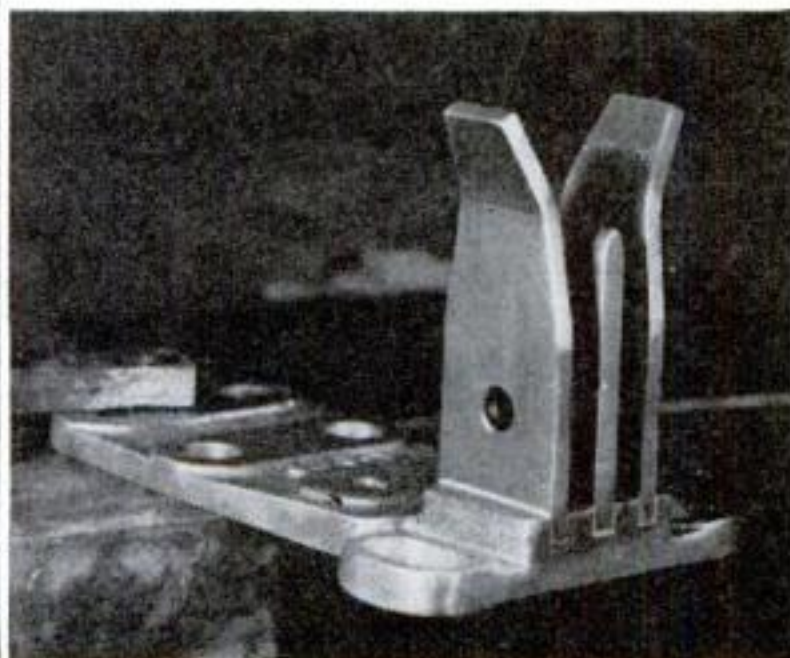
THROUGH THIS DOOR, leading from the Treasury's depository at West Point, has rolled 19,000 tons of silver for duty on the production front. Without this silver, war work might have been curtailed 50 percent



Courtesy of Life

BUS BARS of silver might appear extravagant. But not when they free copper for more important war uses—and at the same time do a better job of conducting the high currents needed in plants where aluminum and magnesium are produced

SWITCH JAWS are cleanly and powerfully brazed with Sil-Fos, a low-temperature silver alloy. In aircraft construction, where every ounce counts, such alloys have proved ideal, for they enable designers to specify lighter materials than were formerly used



SOME OF THE IMPORTANT WORK SILVER DOES AT HOME



BEARINGS for airplane engines are now being covered with silver coatings three to five one-hundredths of an inch thick. Because of its high heat conductivity, a coating of this type guarantees a cool-running motor. Experts estimate that without such bearings air speeds might, in some instances, be reduced by 75 m.p.h.

REFLECTORS employed in floodlights and antiaircraft searchlights are no longer "silvered" with aluminum. They are now silvered with the real thing. In conserving aluminum for other uses, the new reflectors have been known, in a number of cases, to have improved lighting efficiency by 30 percent



the connecting-rod bearings. Today, by a process involving the use of potassium cyanide, coatings of silver with a thickness of from three to five one-hundredths of an inch are deposited on bearings. This new method gives a fine-grained, easily machined bearing surface with high heat conductivity which guarantees that the motor will run cool. Other advantages are that silver is exceptionally strong for its weight, is corrosion-resistant, and has the virtue of absorbing grit instead of being scored by it. While its friction properties are about those of lead, tin, and cadmium, it has a higher melting point than these and—most important of all—an unusually high degree of fatigue resistance.

Some estimates indicate that without silver-plated bearings air speeds might be reduced in certain instances by as much as 75 miles an hour. Over 5,000,000 ounces of silver were used for this one purpose alone in 1943.

Silver brazing alloys were originally designed as a substitute for soft solders. But once the airplane plants started to use the silver alloys, they found that their ability to be worked at low temperatures made them ideal for light-gauge metals used in aircraft equipment.

The reliability of these new alloys is best demonstrated by one use for which they

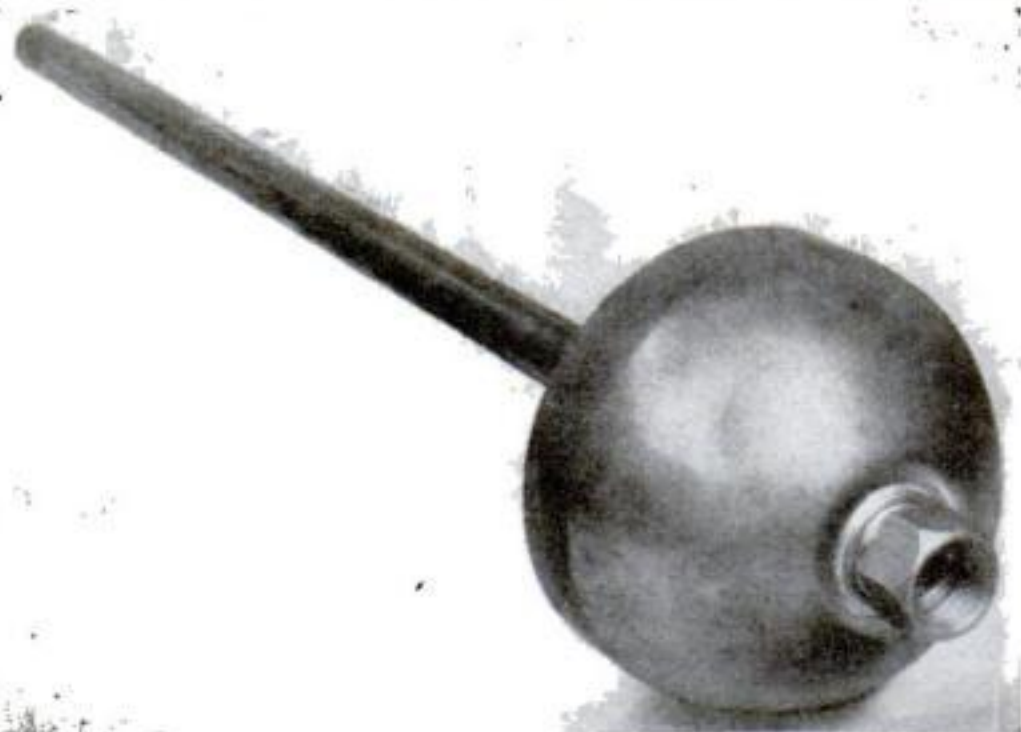
have recently been adopted. When everything else fails, a pilot must count upon his parachute. To insure against its failure, monel-tubing rip-cord rings are now being assembled with silver-brazing alloys.

Silver not only helps our airmen to fly. Flyers actually throw silver away every time they press the bomb-release button. For silver alloys and flux are being used to join the nosepieces to the tubular members of the burster cases of aerial bombs. More than 21,000,000 incendiary bombs are now being manufactured with silver alloys, which have been found ideal for joining the steel tube to the hexagonal nosepiece.

Gunners now use silver—to throw silver. The 155-mm. fieldpiece uses silver in its recoil chamber, where, in conjunction with rubber and leather packings, silver-plated cup rings serve to retain oil and gas pressure. Proportionate amounts of silver are used on other guns from eight-inch howitzers down.

In shipbuilding, scores of yards are using silver alloys to form joints in vital pipe systems. Silver's heat conductivity, strength, and easy workability have led to its being specified for lubricating-oil lines, salt-water lines, systems containing inflammable liquids and gases, refrigerator lines, condenser piping, vacuum systems, and many other places on every naval vessel.

IN MANY IMPLEMENTS OF WAR, SILVER IS DOING



FITTINGS on this nosepiece and exploder tube for a 100-pound bomb have been brazed with a silver alloy. In some airplanes, nearly 200 parts are held with such a compound

PLANE-CABIN HEATERS need from two to three ounces of silver each in their construction. With over 150,000 planned by the U. S., nearly 500,000 ounces of silver will be required for them



PLANES



BOMBS



TANKS

Before the war, soft solders were composed of 40 percent tin and 60 percent lead. Today 2½ percent of silver is combined with lead, thereby completely replacing tin in some solders. An idea of the tremendous quantity of tin which is saved by this new method can be gained when we consider that over 1,000,000 pounds a year are being saved by a single firm alone, the General Electric Company.

Silver is saving aluminum, too. Formerly, the reflectors of street lights, searchlights, and floodlights were plated with aluminum. Today, these vital glass reflectors are silvered and then covered with a copper-plated backing. By this substitution, one large manufacturer has saved a half million pounds of aluminum.

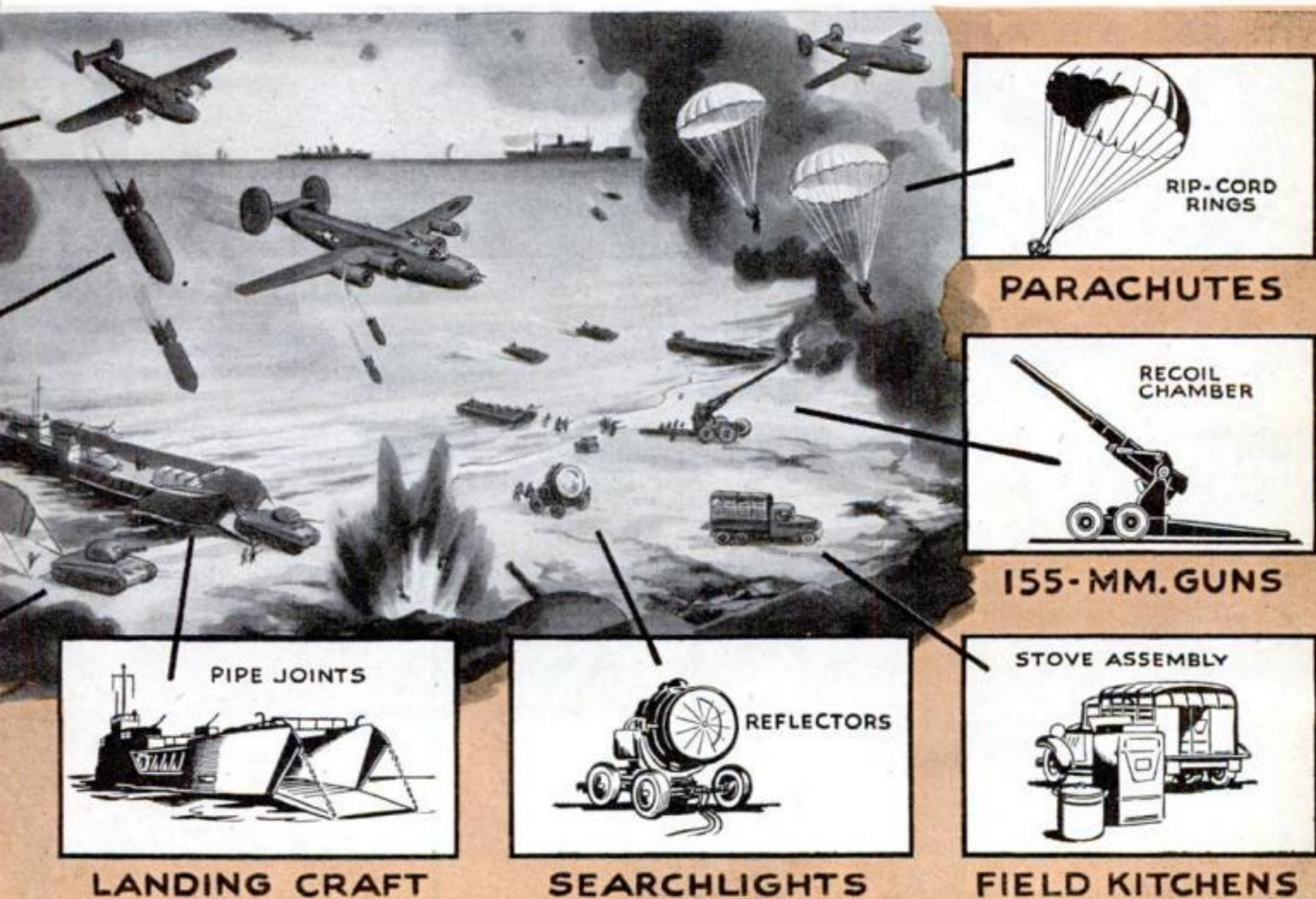
In making electric circuit breakers for handling heavy currents, silver is used in another form. The metal is powdered and mixed with powders of tungsten, molybdenum, and nickel. Then, by pressing and sintering, contacts possessing the high conductivity of silver, plus the refractory and nonwelding characteristics of the base metals, are formed at low cost.

In a similar manner, silver is mixed with graphite to form generator brushes. Here again, the high electrical conductivity of the metal is the reason for the new application. In some cases, only a tiny bit of silver

is needed to replace large quantities of other metal. Copper, for instance, is one of the best electrical conductors, but when it is alloyed with other metals for strength or heat resistance its ability to conduct electricity is greatly reduced. Silver does not have this disadvantage. A mere teacupful of silver mixed with a *ton* of copper has been shown by Westinghouse engineers to make an alloy twice as heat-resistant as ordinary copper, and just as conductive. Such silver-bearing coppers are already being used in the commutators of direct-current motors. These commutators, turning at high speeds while heated, prove to be far more efficient than those formerly made of pure copper.

These and countless other new uses for silver have stepped up our silver consumption by between 500 and 600 percent over prewar days, when we used 41,000,000 ounces each year, mostly for silver-plated flatware, coinage, and similar "luxuries." Even with imports, we got only about 162,000,000 ounces of newly produced silver in 1943; and our use of silver, despite a 50-percent cutback in nonessential applications, soared to between 210 and 260 million ounces. Today our war production would be in a desperate fix were it not for the "crazy hoarding scheme" which produced the gigantic silver reserve at West Point.

A BETTER JOB THAN THE METALS IT HAS REPLACED



WILL YOUR NEXT AUTOMOBILE BE LIKE THIS?

Your Postwar Car... As Popular Science Readers See It

OWNERS AND DRIVERS TELL WHAT THEY WANT
IN THE BETTER AUTOMOBILE OF TOMORROW

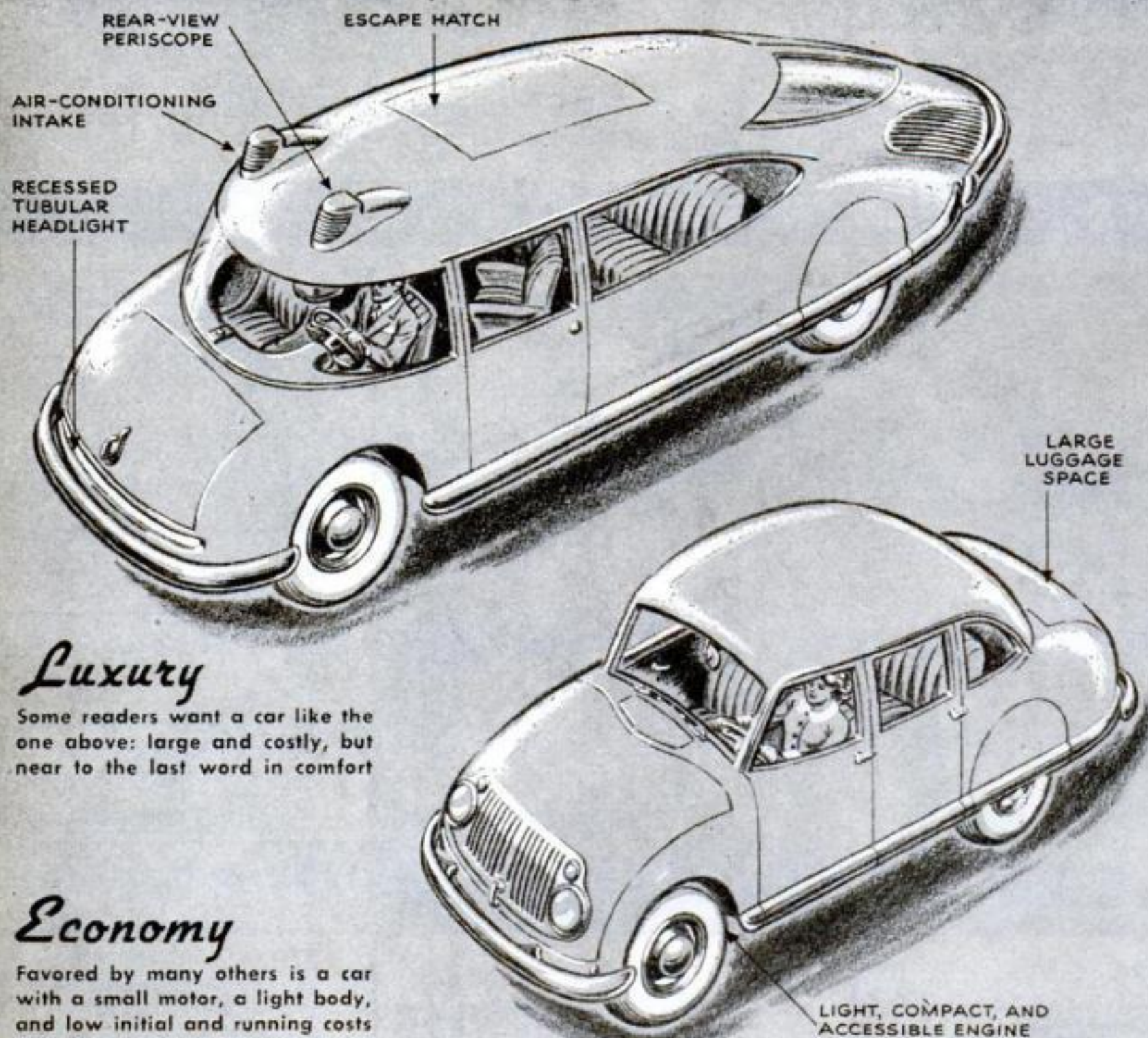
GUS WILSON, with Stan Hicks at his heels, stepped out of the elevator at the POPULAR SCIENCE office and greeted the receptionist with a cheery grin. "You bet it's a fine morning," he told the girl, shifting three bulky envelopes to doff his hat. "Will you tell the Auto Editor we're here?"

In a moment the Auto Editor popped his head from the inner door. "Hello, there, Gus. How are you, Stan?" He escorted them to his cubicle. "Who's holding the fort at the Model Garage?"

Gus laughed as he opened his envelopes. "I left Joe Clark in charge," he said, "and I told him to stick to selling gas and oil. The last time Joe worked on his own bus, it stopped cold right outside the door."

"As a matter of fact, I'm darned glad to come in. Stan and I were talking, and we agreed that a lot of these suggestions about postwar cars from P.S.M. readers sound pretty good. That right, Stan?"

"Sure is, Mr. Wilson," said the Model Garage's grease monkey. "I'd like to have



Luxury

Some readers want a car like the one above: large and costly, but near to the last word in comfort

Economy

Favored by many others is a car with a small motor, a light body, and low initial and running costs

some of those features in *my* next car."

The Auto Editor looked curiously at the stacks of letters Gus was taking from the envelopes. "You'd better bring me up to date, Gus," he urged. "All I know is that when we published 'Previewing Your Post-war Car' last winter, we asked readers to send in their own ideas of what new cars should be like. We got a pretty heavy mail—some letters are still coming in from boys overseas—and since most were addressed to you, we forwarded them."

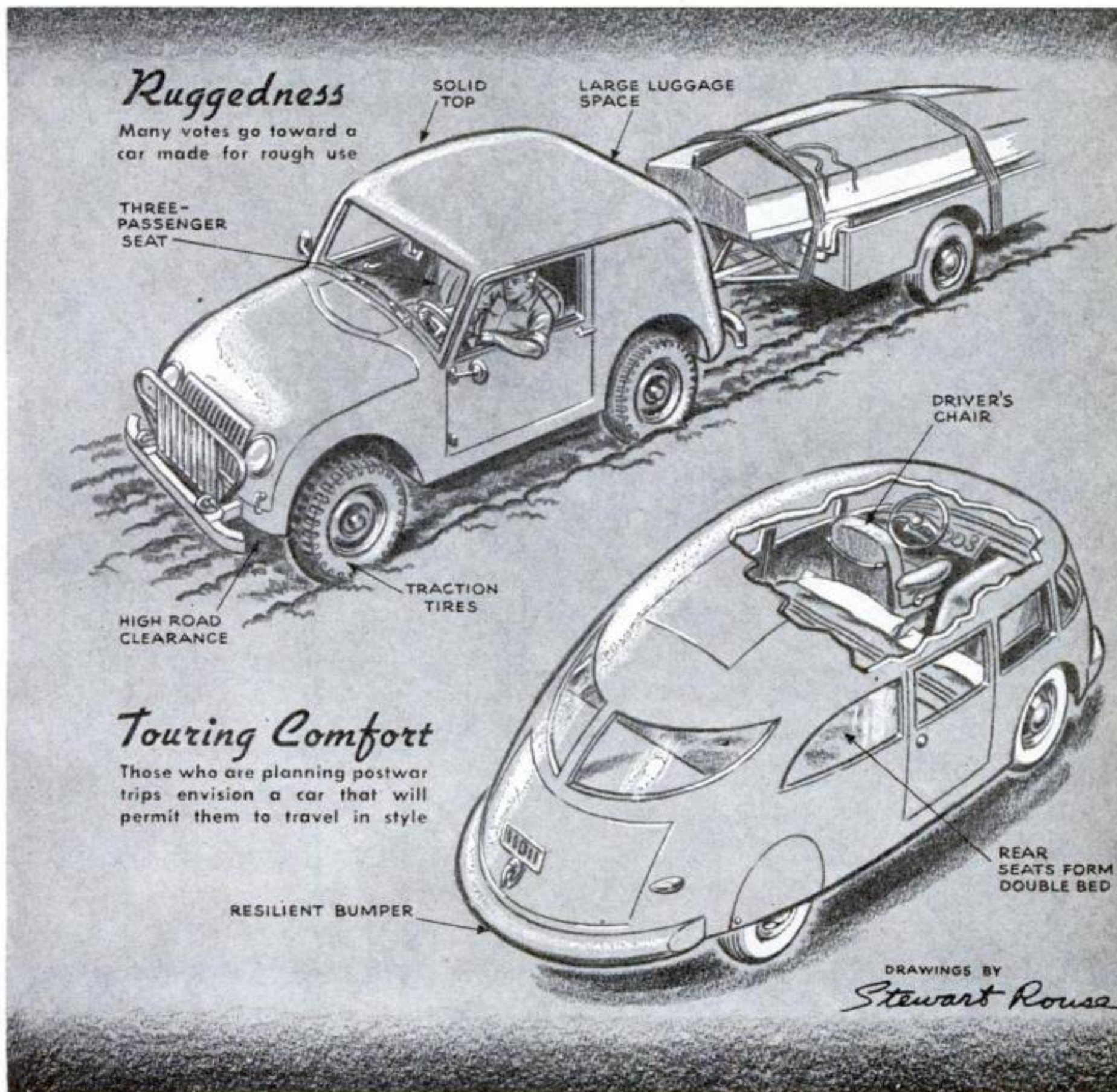
Gus fished his briar out of a pocket and tamped home a charge of tobacco. "These letters make good reading," he remarked. "For one thing, they show car owners know what they want. I've never much held to the notion that people who buy cars are chromium-hungry simpletons who stam-pede after the job that has the brightest brightwork. Strikes me they are a danged sight more likely to pick the car that comes closest to giving them what they want in size, performance, and operating cost."

"What car would you say," asked the Auto Editor, "most people want after the war?"

Gus tilted back in his chair and looked out at the Manhattan skyline. "It's a funny thing, but there isn't any single favorite. People seem to want three wholly different autos. I suppose it depends on where they live, the size of their families, and how a car is going to be used. About a third vote for a super de luxe teardrop—big, powerful, and probably costing a lot. Then there's another big bunch wanting a car for really low-cost transportation—something much lighter than we have now."

"I'd like that myself," said the Auto Editor. "I never could see 3,500 lb. just to lug me to the station every day."

Gus puffed on his pipe. "The third type is a sort of son of a jeep," he said. "It's medium light, built for rough roads and rotten weather. You could use it for hunting and fishing and for light hauling. It would have high road clearance, four-wheel



drive for traction, and extra-large storage space. The motor would be where a man could work on it without standing on his head or spraining a wrist."

"Golly," Stan exclaimed. "That's my car. I hate a job you have to nurse. What kind of a motor would it have, Mr. Wilson?"

"That's hard to say for sure—depends on the manufacturer's ideas, the cost of magnesium, steel, aluminum, and alloys after the war, and a lot of other things as well." Gus paused a moment. "Offhand, I'd guess it might have a light, four-cylinder engine. Might even be a Diesel.

"Small, high-compression engines, air-cooled jobs, and Diesels seem to be pretty popular. Quite a lot of people write that they think two-cycle engines have possibilities. Then there are a good many who think steam cars should never have gone out,

and some are pretty hot for gas turbines."

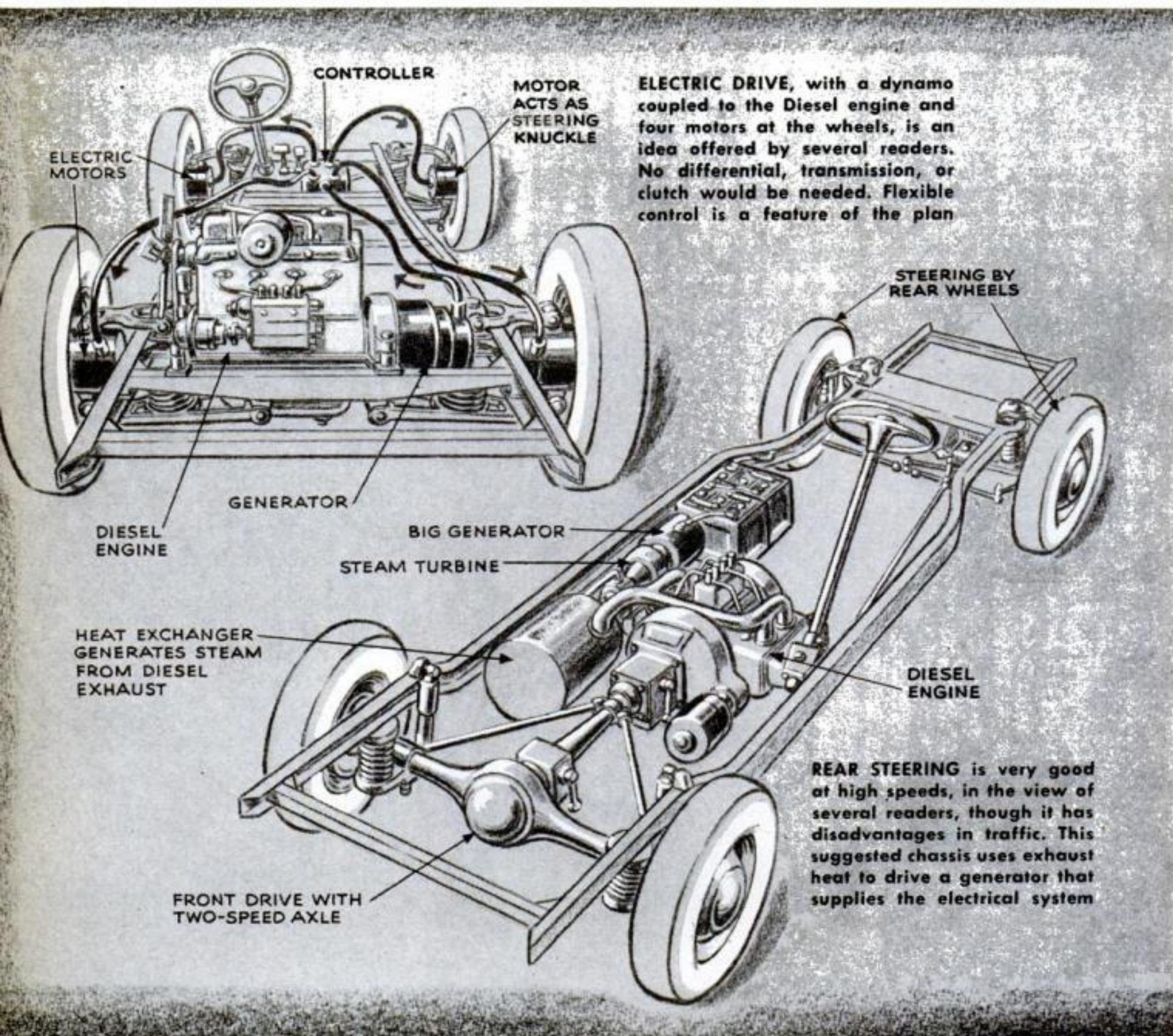
"What are the main criticisms of the cars we have now?" asked the Auto Editor.

"Well, it isn't performance," Gus told him. "Most readers say speeds over 65 don't mean a thing. Ruggedness and reliability seem to mean a lot more. Longer gas and tire mileage are probably wanted most, and I think they'll still be near the top when gas and tires are easier to get.

"Plenty of readers don't cotton much to automatic chokes, clutches, transmissions, and the like. As one man puts it, he wants to run his car himself. Other peeves are low road clearance, motors that are tough to work on, and lack of provision for hand cranking when a battery goes dead."

"Look," said the Auto Editor, "how about some specific engine suggestions?"

Gus picked up a stack of letters. "Here's



one from Lt. Commdr. H. D. Hill, of Norman, Okla. 'The engine should be either gasoline or Diesel, preferably air cooled, but if liquid cooled it should have manually adjustable thermostats. It should have an injection-type carburetor which also incorporates enough of the features of an ordinary, float-type carburetor so that if the injection pump fails, the engine can still be operated until repairs can be made.

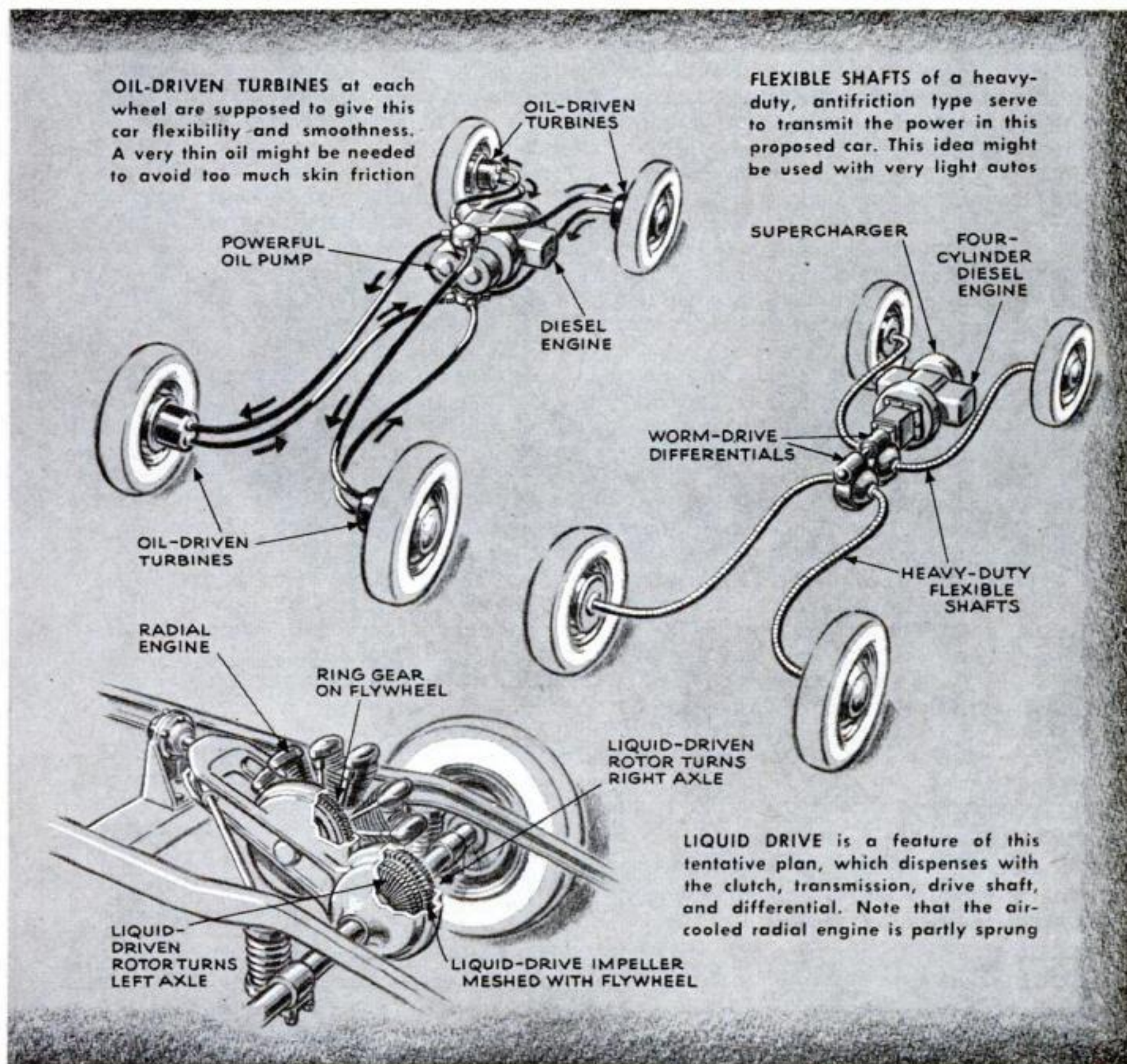
"This engine should be constructed like a plane engine with cylinder barrels bolted to a crankcase. It should be mounted so that all parts are completely accessible for easy maintenance. Probably a radial or a flat, opposed design, mounted in the rear, will fit into the car contours better than an in-line design.

"Like a plane engine, it should also have an oil reservoir separate from the motor,

and in this there should be a heating element that could be turned on in cold weather to permit quick starts and fast driving without delay. Fuel lines should be made of a flexible plastic. The car should have a four-wheel drive, with the drive on each wheel controllable manually.'"

"Sounds good," said the Auto Editor. "I suppose independent cylinder barrels could only be used on the air-cooled version, though."

"Strikes me that Commander Hill has some fine ideas," Gus went on. "One thing I don't go along with him on is manually controlling the drive on each wheel. That means, as I see it, some method of temporarily locking the differentials. It might be handy in pulling out of a mudhole where the wheels are bogged on only one side—but it wouldn't be so hot with an inex-



perienced or careless driver who might neglect to unlock the differentials later.

"Here's an idea from P. C. Storr, of Marin City, Calif. 'I would like to suggest that the power plant be connected to a heavy-duty dynamo which would in turn drive independent electric motors in each wheel. It would save tires and eliminate clutch, differential, transmission, and drive shaft. Magnetic brakes could be used, too.'"

"That's worked well with locomotives and ships," remarked the Auto Editor. "You might be able to have an engine with a smaller useful speed range than you might otherwise need."

"There might be something in using poly-phase A.C. motors," Gus said. "They have a rotating magnetic field that might act much like a fluid drive. Also, they'd eliminate the nuisance of servicing commutators and brushes. But I'm only guessing—it's a problem for the slide-rule boys."

"Now here's an interesting idea from Bill Light, of Columbus, Ohio. He says: 'The Diesel is about the most economical engine we have today, and I want one in my car. In addition, why not utilize the exhaust heat to generate steam which would assist the engine on longer runs? Maybe it would take more space, but it would use heat units that would otherwise be lost.'"

"That's tricky," commented the Auto Editor. "But a turbine, or even a reciprocating engine, isn't cheap. There'd also be a problem in getting synchronism."

"Just the same," Gus pointed out, "they do that on some big, fixed Diesel installations. Maybe it could be adapted for long-haul buses and trucks. It might be practical to hook the turbine up to the extra-large generator we may want to run air conditioning, radios, and so on."

Gus lit his pipe again. "There are so many ideas that I'll just mention a few. Dwight McKesson, of Walkerston, Ind.,



Built into the framework of the car, this trailer hitch has extra strength. A cord and socket connect the lights

wants an air-cooled motor, maybe a five-cylinder radial or a four or six-cylinder opposed. He'd like a liquid-drive unit combined with a modernized version of the old Model T planetary-gear transmission.

"Then there's Phil Vormerk, at Camp Sutton, N. C., who suggests a four-cylinder engine, in pancake or V-type form, working on the two-cycle principle. It could drive a flexible-shaft system to all four wheels, he says, with the shafts large enough and sufficiently well lubricated so there would be no serious friction losses."

The Auto Editor scratched his head. "How efficient

would flexible shafts be?"

"That's one for the engineers," Gus said slowly. "Mr. Vormerk believes a car with four-wheel drive and independently sprung wheels would hold the road better and would be good in muddy and icy going. Then he adds that a liquid-drive unit might be installed at each wheel—dispensing with transmission, differential, universal joints, and propeller shaft. Of course, he would need a reverse gear somewhere."

"Harry Stewart, of New York, has an idea for smooth, light, and simple propulsion. He wants an air-cooled radial mounted in the rear on a half-sprung yoke. The engine would be geared to a liquid-drive impeller, and on each side of this there would be driven rotors connected to the rear wheels. All you'd need do to start would be to press down on the accelerator—no clutch, transmission, differential, or drive shaft."

"Say," Stan chirped, "that's neat."

"Sure," Gus grinned. "But there's no way to back out of the garage. However, it ought to be possible to reverse with some arrangement of planetary gears in the fly-wheel."

"Carpenter's Mate Wayne Brokaw, of Indianola, Iowa, wants a true hydraulic—not liquid—drive, a pump on the engine and oil-driven turbines at each wheel. He picked up the notion from the steering engines and turret controls on warships."

"But that's about enough for now. I told Joe I'd be back at the Model Garage right after lunch for sure so he could get back to his books. Next month, when I can get in again, we can take up some of the ideas that readers have for body design, and also some of their notions for accessories and gadgets in these dream cars."

CREDIT to Black & Decker Mfg. Co., of Towson, Md., was inadvertently omitted from the article "Good Valves Give Engines Extra Punch," by Ralph Rogers, in the April, 1944, issue of POPULAR SCIENCE MONTHLY. Drawings and some of the material were taken from the Black & Decker booklet, "The Principles of Valve Reconditioning," and should have been so credited.

Gus Hits a Hot Spot

AN OLD CAR. UNLIKE AN OLD DOG, CAN LEARN A NEW TRICK

By Martin Bunn

STAN HICKS came through the door of the Model Garage shop with a wide grin on his grease-streaked face. "Noah's outside," he announced.

Gus Wilson looked up from the bench job he was finishing. "Noah?" he asked. "Noah who?"

"I dunno his name," Stan said, "but he's in a car that's as old as Noah's ark. He wants to see you."

"Sounds like C. Watson Griggs," Gus said. "Tell him I'll be right out. And don't be fresh—he lives on his place in the country now, but he's still the leading citizen of this town."

When Gus went out, he saw an expensive, well-kept sedan of pre-Roosevelt vintage. Bolt upright behind its steering wheel sat a man who seemed its counterpart. A stiff straw hat topped carefully brushed white hair, a high collar set off a blue polka-dot bow tie, and though the day was hot, he wore a blue serge suit and vest.

"Why, Mr. Griggs!" Gus exclaimed. "Where's Hamby?"

Griggs blinked through glasses safeguarded by a black ribbon. "Hamby," he said solemnly, "is serving his country. Since day before yesterday . . . Mr. Wilson, I've had a most disconcerting experience!"

"I can understand that," Gus assured him. "Hamby's the sort of man it isn't easy to replace—as good at taking care of a car as he is at driving it."

A wave of Griggs' hand stopped him. "We must make sacrifices, Mr. Wilson—all of us," he said. "I let the Army have Hamby willingly. And I shall make no effort to replace him. While he is serving his country, I shall do my bit by driving myself."

"That's very patriotic," Gus commented.

"Yesterday I practiced on the driveway," Griggs continued, "and was pleased to find that I had retained my old skill. When I left home this morning to attend a directors' meeting at the bank, everything went well until I attempted to apply my brakes while descending a hill. The pedal went down without causing the car to slacken its speed, Mr. Wilson, and it required considerable manipulation with my foot to bring it back to its normal position—'pumping,' I think, is Hamby's word for the operation."

"A few minutes later, I pressed on the

brake pedal at a traffic light that had turned to red, but again it went down without slackening my pace. Traffic on the cross street had started by the time I reached the light. I was helpless, Mr. Wilson! My car shot across the intersection, and a truck approaching from my left avoided me only by swerving behind me. The driver of a car from the other direction saved it from being struck only by a sharp turn."

Gus whistled. "That was a close call."

"Indeed, Mr. Wilson," Griggs continued. "My brakes, I decided, needed prompt attention. I drove slowly until I came to the first garage, where I had my braking system checked from end to end, but they could find nothing wrong with it and told me to try it out for myself. To my surprise the brakes worked perfectly. I paid the man and drove on, thinking that in the course of his examination he must unknowingly have corrected some slight maladjustment."

"But after a few minutes, a car some distance ahead of me slowed down suddenly. I also attempted to reduce my speed, but again I depressed the pedal without the brakes taking effect. Only the fact that the car ahead of me speeded up again saved me from crashing into it. Now many and many a time Hamby has said to me: 'Gus Wilson is the man to go to when you are in a jam with a car. If he can't make it run, nobody can.' So, Mr. Wilson, here I am."

GUS was glad of an excuse to grin. "I'll try to live up to Hamby's opinion," he said. "If you'll drive into the shop, Mr. Griggs—or perhaps I . . ."

"Not at all," Griggs said. "My only difficulty has been with the brakes."

He stepped on the starter, and there was a report like a pistol shot.

"You need a new muffler, Mr. Griggs," Gus told him.

"Yes, I noticed that the car was making an unusual amount of noise," Griggs agreed. "Hamby told me when he left that I should bring it in to you to have a new muffler installed."

"First let's see what's wrong with your brakes," Gus said.

Griggs consulted his watch. "I'm due at the directors' meeting. If you will make



At the wheel sat the counterpart of the well-kept ancient sedan

whatever repairs are necessary and deliver my car to the bank, I shall be obliged to you."

When Griggs had left, Gus called Stan.

"Here's a chance to do a little trouble-shooting," Gus told him. "When the brake pedal goes to the floor board without operating the brakes, what's likely to be the cause?"

Stan scratched his head. "It might be a leak in the system," he said. "Or air in the system."

Gus nodded. "It might be, but it also might be lack of brake fluid in the master cylinder. That's the thing to look for first. Check the supply tank."

But the check showed the tank to be full. "All right," Gus said. "Block the front wheels and jack up the rear wheels."

Gus started the engine and shifted into low. When he pressed the pedal, the brakes acted promptly and evenly. Gus switched off the engine and got out.

"Let her down," he told Stan. "We'll have to bleed the system. There must be air in it—although there's no spongy feel to the pedal. Get that bleeder drain off the shelf and a clean pint can."

Gus removed the bleeder screw from one of the wheel cylinders, screwed in the brass bleeder drain, and placed the rubber tube attached to it in the can so that its end was below the surface of the small quantity of brake fluid that he had poured into it.

"Press the pedal all the way down with your hand—slow," he told Stan. "Do it ten times. That gives a pumping action that forces the fluid and any air that may be in it out of the wheel cylinders."

Stan pumped, but no telltale air bubbles appeared. After they had bled the other three wheel cylinders with the

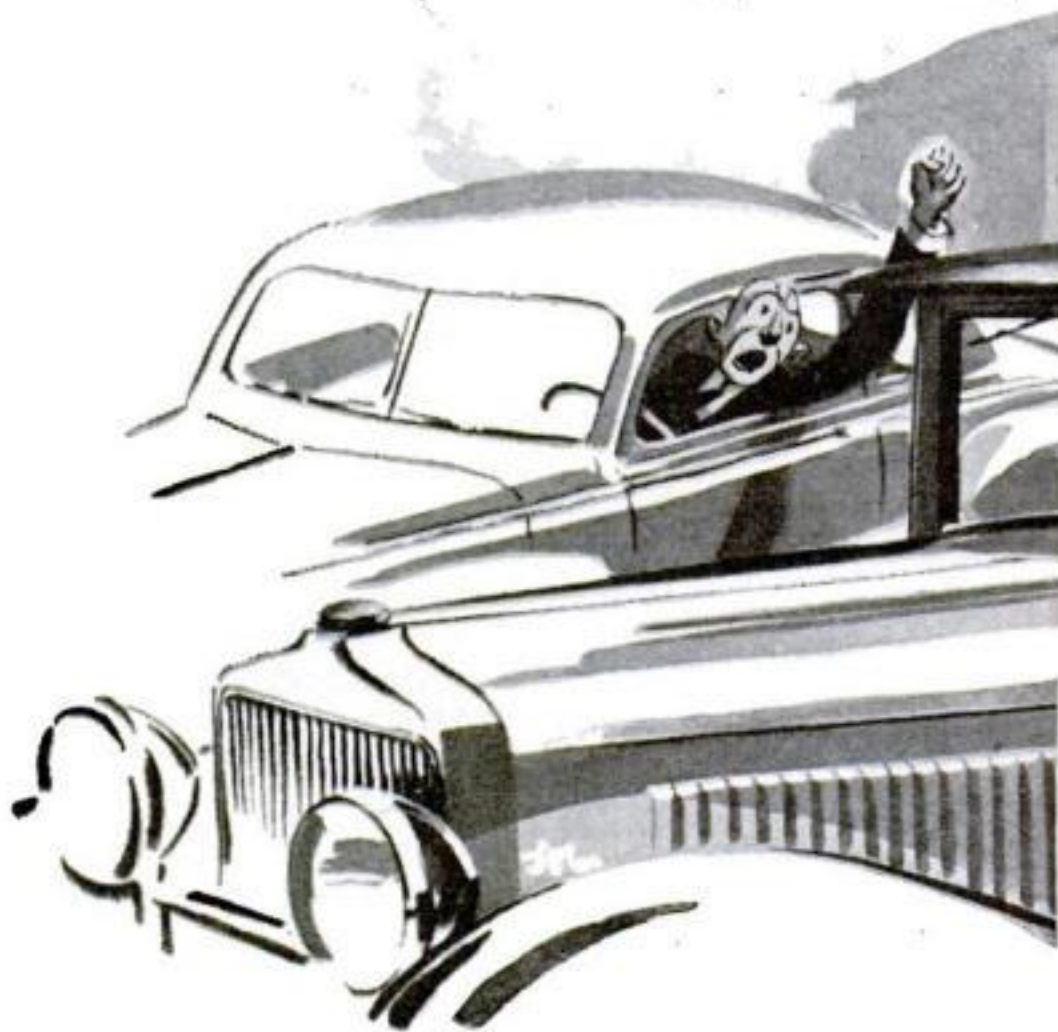
same result, Gus took time out to light his pipe.

"Either Mr. Griggs is nuts, or I am," he remarked. "Maybe a road test will decide which. Fill up the supply tank with fresh fluid, Stan, and we'll go for a ride."

Gus drove out of the shop and up the street, stopping every half block or so. For five minutes the brakes acted perfectly; then suddenly the pedal went down to the floor board without applying the brakes. When Gus pumped it carefully with his foot, the pedal gradually returned to its "off" position, and for a minute or two the brakes acted normally. Then the pedal went down to the floor again without slowing the car and had to be pumped back to normal.

"This isn't getting us anywhere," Gus

Only sharp swerving by a truck and another car kept him from having a bad smash-up at the intersection



said as he pulled in to the curb and stopped. "This is a job that's got to be *thought out*."

Just then Trooper Jerry Corcoran roared up on his motorcycle and stopped beside them. "Oh, it's you, is it?" he said. "Say, Gus, don't you know that there's a law against driving without a muffler?"

Gus grinned at him. "This is C. Watson Griggs' car," he said. "You don't think *he'd* have a car without a muffler, do you?"

Jerry grinned back. "He might have, now that Hamby's gone to the war," he said. "But if there's a muffler on that antique, it must have a hole as big as a quarter blown through it!"

"Holy cats, Jerry," Gus said, "you've given me the answer."

Back in the shop, Gus crawled under the car. After half a minute he wriggled out.

"Get a new muffler from the stockroom and install it," he said. "Then drive the car down to the First National and leave word for Mr. Griggs that it's ready."

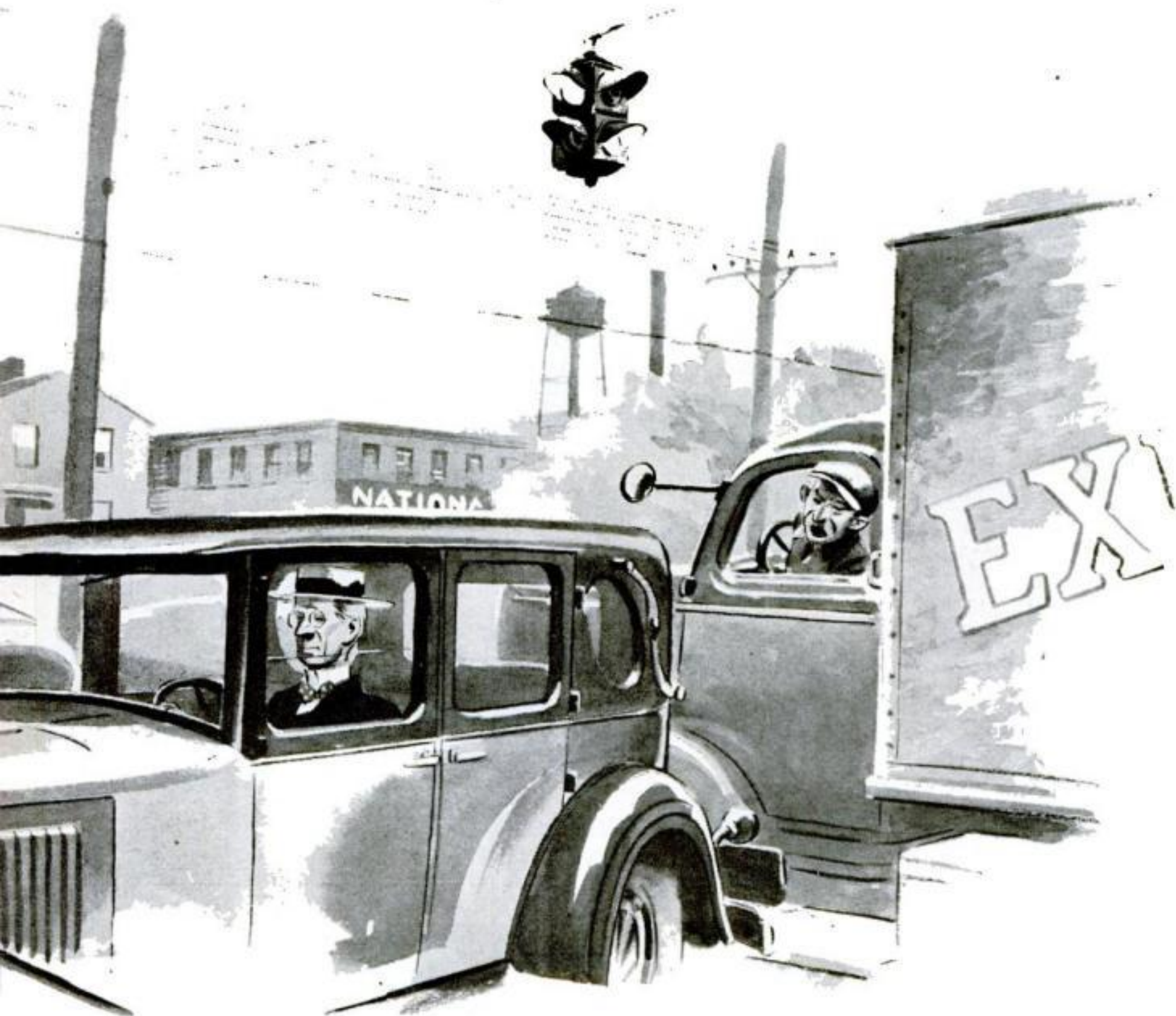
"O.K., boss," Stan agreed. "But how about fixing the brakes?"

"A new muffler will fix them," said Gus. Stan scratched his head. "Now *I'm* getting nutty," he said. "I don't get it, boss."

"I didn't get it either," Gus said, "until Jerry made that crack about the muffler having a hole blown in it. When you take the old muffler off, you'll find the hole, and you'll also see that the copper tube carrying the brake fluid to the rear wheels runs close alongside the muffler where hot gas will blow on it from the hole. Heat from the muffler vaporizes enough fluid to cause a soft pedal. Pumping on the pedal builds up pressure that liquefies the vapor so the brakes work O.K. again—until the heat does some more vaporizing. When the engine has been shut off a few minutes, the vapor liquefies itself."

Stan shook his head. "Sometimes," he said, "I wonder why I don't get an easy job."

"Sometimes," Gus told him, "I do, too."



MADE IN HOME WORKSHOPS U. S. A.

CELLOS ARE A HOBBY as well as a business with Henry Fabrizio, below. He makes them and he also plays them, for he is violincellist with the Boston Symphony Orchestra. Fabrizio works on the construction of cellos in his spare time, using only the choicest woods. One he made for himself so impressed cello virtuosos who saw it that he received orders from them.



THIS DOUBLE-BARREL BRUSH GUN is the original idea of H. C. Thiessen, tool engineer of the Hart-Carter Company, New Holstein, Wis. The lower 26" barrel, fired by the rear trigger, is designed for a first quick shot and the upper for a follow. All work was done on an 11" lathe. Thiessen made even the smallest screws.



CARVED FROM CHERRY, this 12" hardwood horse is the work of W. J. Hayman, captain of the guards at the plant of The Cooper-Bessemer Corporation at Grove City, Pa. It was made from a single block with ordinary knives and files, and Hayman worked on it at intervals during spare time for seven months. He finds the piece symbolic of the thousands of horsepower in Diesel and gas engines built by his company.



WOUNDED IN THE SOUTH PACIFIC, Seaman 2/c George Earl Evans, of Richmond, Va., spent part of his convalescence at the Naval Medical Center in Montgomery County, Md., building the warping frame shown above. This and other devices he made are used in the occupational-therapy department at the Navy hospital.

POPULAR SCIENCE



A GARDENER'S EASY CHAIR has been made by George T. Eager of Philadelphia, to ease back strain as he plants and weeds. The bench is set on wheels cut from the ends of old croquet mallets. It slides up and down the garden rows on 16' wooden tracks, made from 2" by 3" stock, that can be laid wherever desired.

HEAVY FIRE EXTINGUISHERS of the carbon-dioxide type, not easy to carry by hand, can be quickly trundled to the scene of a fire with a wooden-wheeled carrier of the kind shown. Developed by the Royal Canadian Air Force for use on training and operational fields, the carrier requires only several lengths of pipe and a pair of hardwood wheels. It's also suitable for garages, farms, and factories.



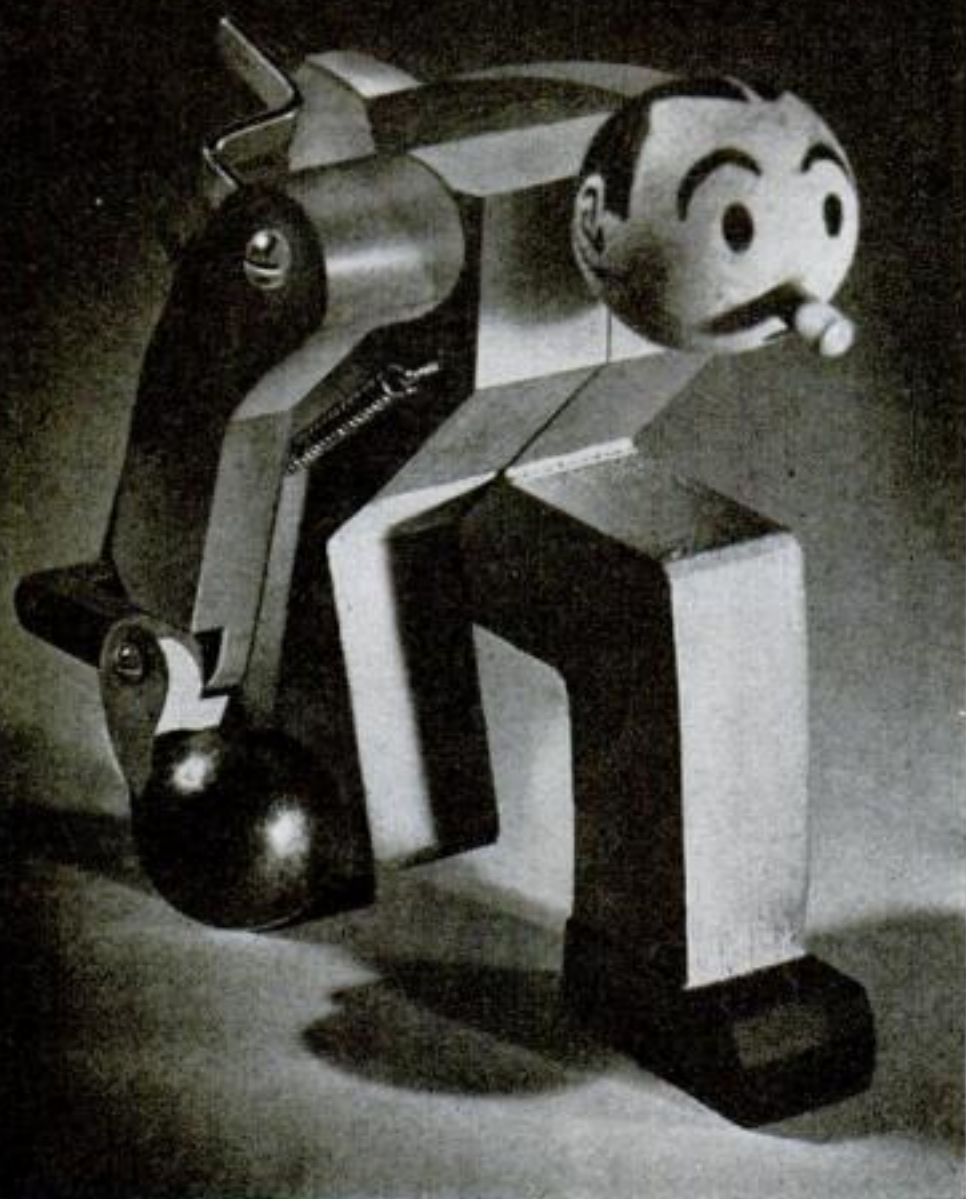
PATTERNS FOR POULTRY HOUSES. Makers of asbestos-cement board adapted a device from the dressmaking trade when they designed full-size paper patterns for use in constructing chicken houses and brooders. The patterns for the various elements, walls, roof, and so forth, are simply laid out on the boards and traced. Although they are scaled for buildings measuring 4' by 8', they may be adapted to multiples of that size. Minor details of the assembling process—even where nails should be driven—are marked on the patterns. A further aid to the builder is a list of the kinds and amount of materials needed.



WOODEN SNAKES painted with bright-colored stripes are the latest thing in scarecrows and have been placed on roofs of State buildings in St. Paul, Minn. They are intended to frighten away pigeons, which for some obscure reason always seem to nest on public edifices. Above, some of the fake reptiles are shown being arranged on a ledge of the State Capitol by Julian O. Sletten, State Director of Public Property. Stuffed hawks will also be used as a combative measure.

MINIATURE

All the Thrills



By **CARL W. BERTSCH**

EXPERIENCED keglers and tyros alike will get amusement from this 5' bowling alley that can be set up in a basement playroom or be brought out into the living room or on the porch for the entertainment of company. It will provide all the thrills of tournament play when the official rules are followed, but for those unfamiliar

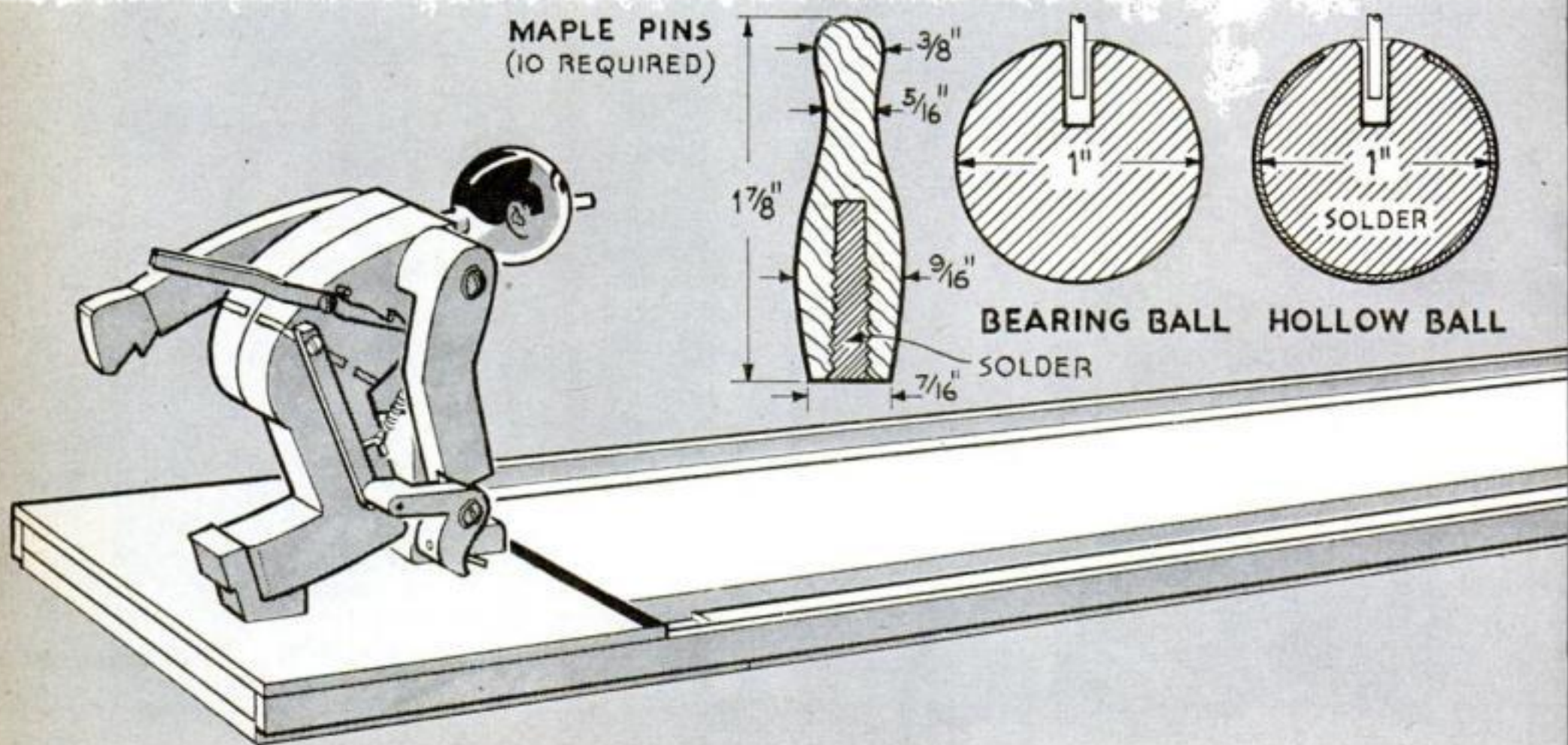
with bowling, any simple set of rules will assure keen competition and a lot of fun. Balls, pins, and all parts, with the exception of the length of the alley, are modeled to scale.

Benny the Bowler, who rolls the ball for you, is jigsawed in two halves and glued together. Saw the left arm in one piece and glue it in place. The right arm and hand are separate pieces and are drilled to swing loosely on wood screws. A short length of curtain spring, attached as shown, will pull the arm forward with a sharp snap that will roll the ball with considerable force.

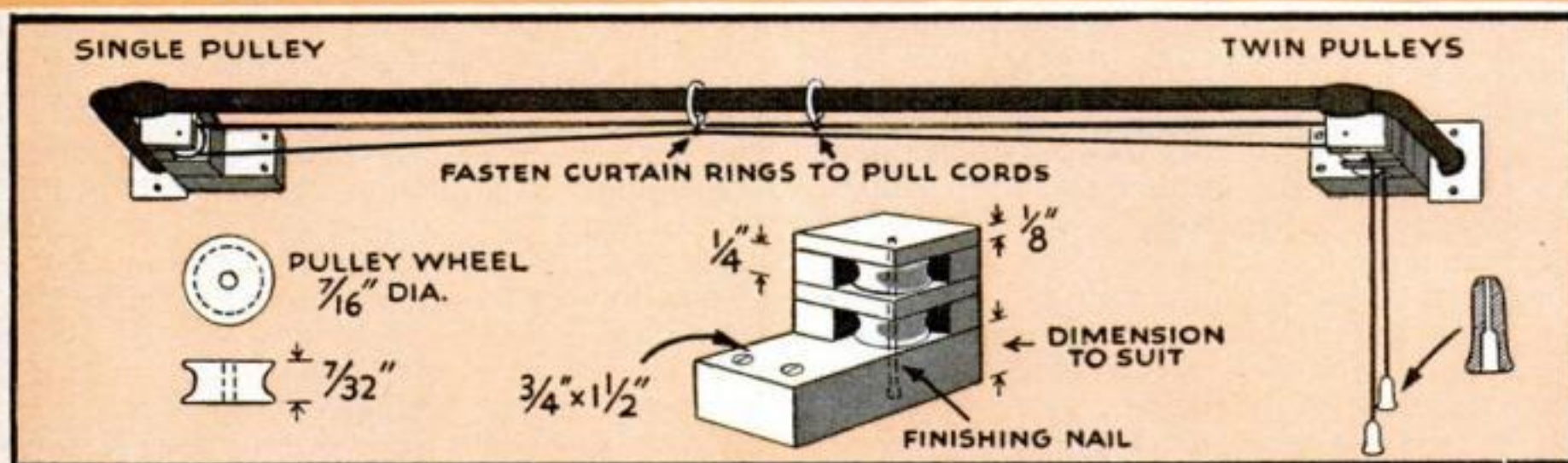
Fine bowling balls can be made from 1" steel ball bearings heated to a cherry red and allowed to cool in air to draw the temper so they can be drilled to hook loosely onto Benny's finger. Bevel the edge of the hole to lessen friction. Hollow metal curtain-rod balls may also be used if filled with solder and similarly drilled, or hardwood balls may be turned and weighted with lead poured into two holes bored on opposite axes.

Cut maple stock for pins to the proper length and bore one end deep enough for solder or lead weight and of a diameter that will screw tightly on the lathe screw center. Since the pins are only $1\frac{7}{8}$ " in length, support with the tailstock is unnecessary.

Details for the construction of an alley, using 1" thick plywood for the bowling sur-



KEEPING THE HOME



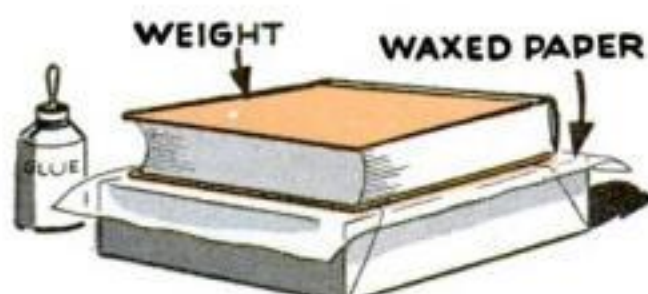
With less than 1" of a 7/16" dowel, all three of the pulleys shown above can be made for a draw curtain. Cut each to 1/4"; then file the cord groove on the outside and drill. Assemble the housings and sand the pulleys to about 7/32" for a free fit that won't let the cords jam. The 1/4" blocks are L-shaped. To install, fasten the middle curtain rings to opposite cords

If lights in a front door are too high for you to see who is calling, a mirror on the ceiling of the alcove outside will help you identify your visitor. Use one 4" by 10" or larger

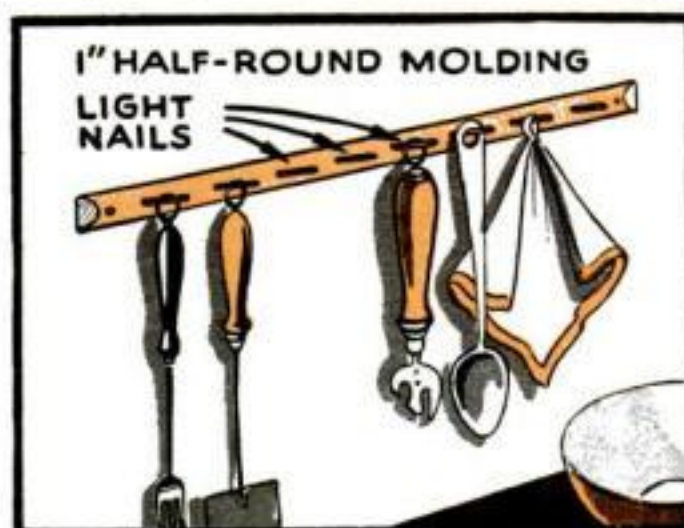


HEAVY-GAUGE WIRE

Heavy-gauge wire coiled around a vase and decorated with paint makes an attractive wall holder for plants



Waxed paper laid on top of articles that have been glued or pasted keeps weights on them from adhering

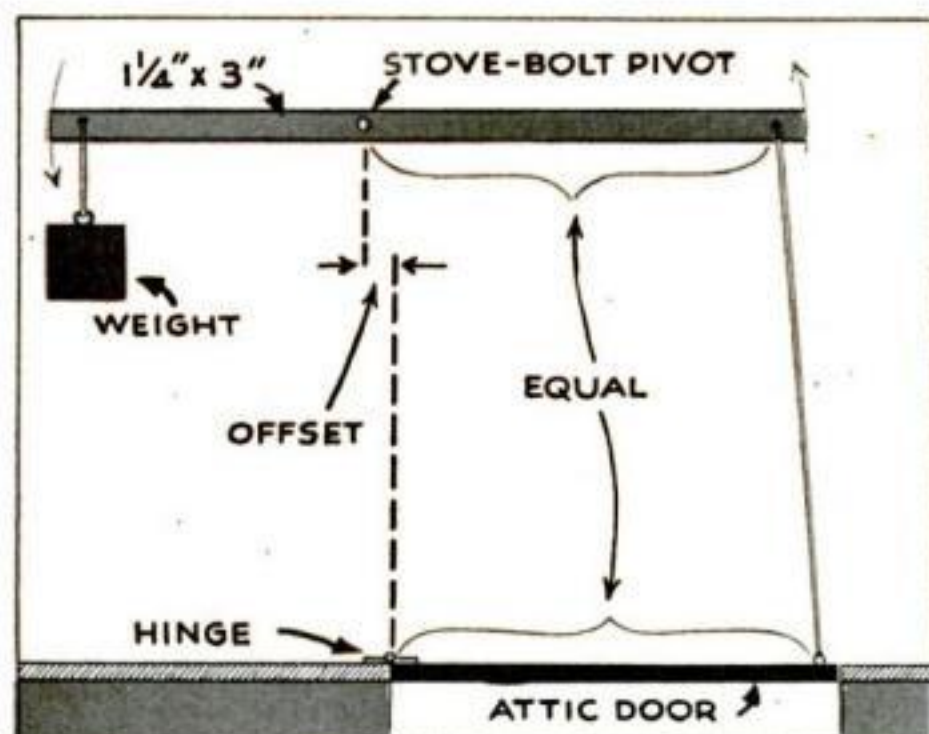


For kitchen hangers on plaster walls, drive finishing nails into half-round molding. A piece at least 18" long can be screwed firmly into two studs

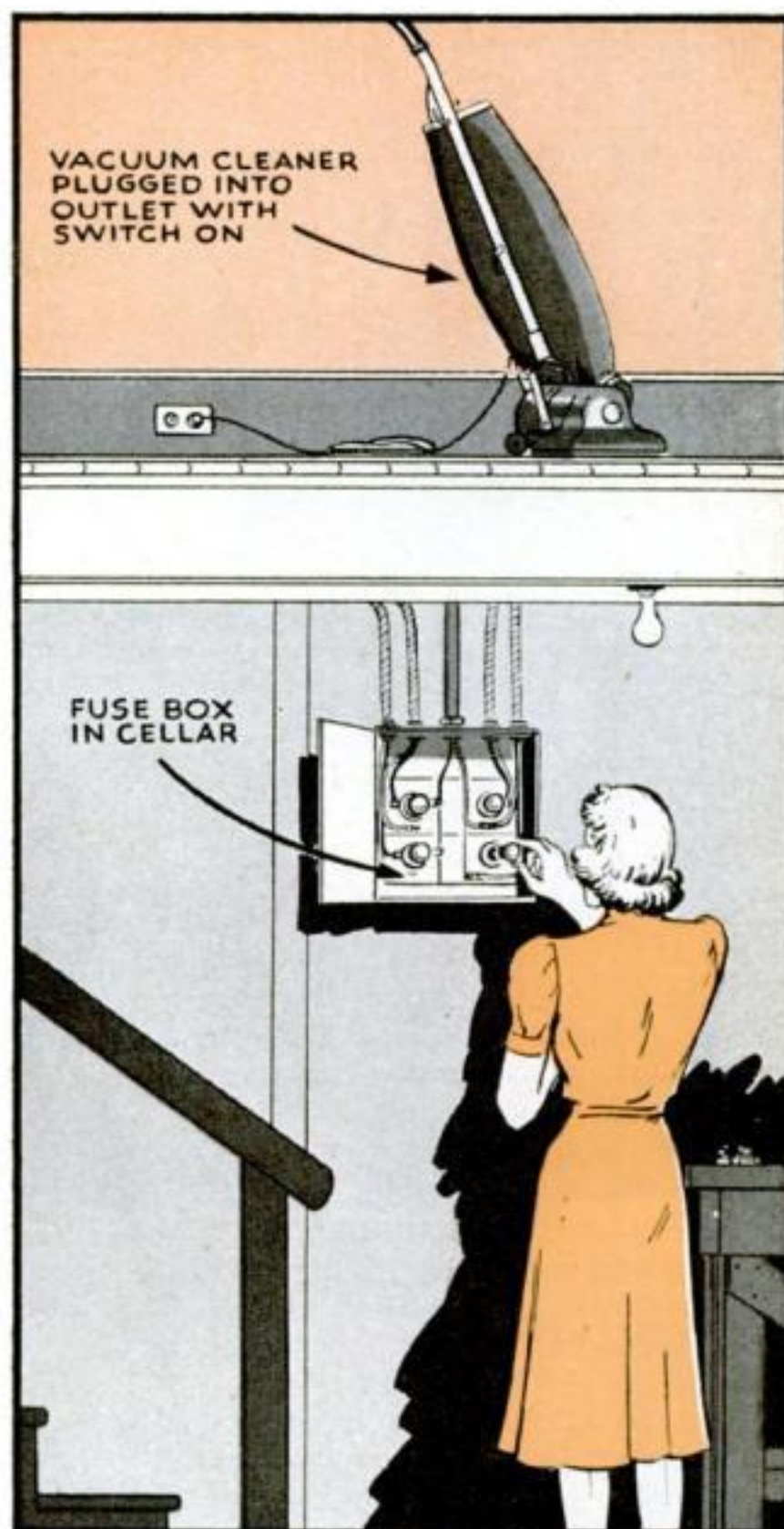
SHIPSHAPE



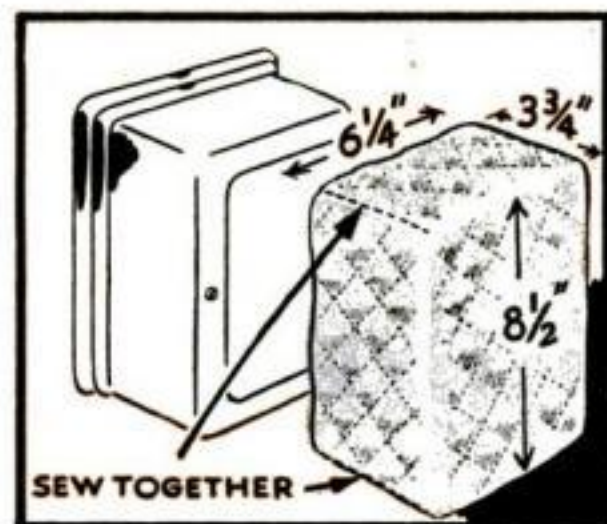
Paint can be mixed thoroughly with a stirrer, like the one above, utilizing the bottom and part of the side of a tin can. Punch holes in the disk to let paint through, and stir with an up-and-down motion



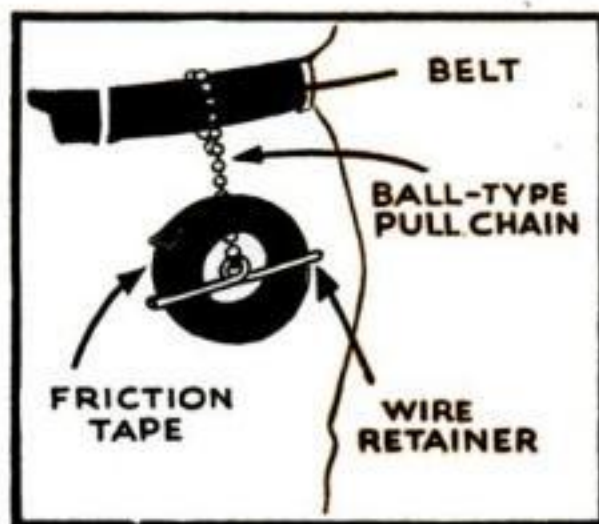
Attic trap doors are often awkward to open because ordinary counterbalances don't hold well in every position. This can be corrected with a rope fixed to the end of a pivoted, counterbalanced lever, as shown. Make sure the distance from rope to pivot is equal to the corresponding dimension on the door



Before going down cellar to replace a fuse that has blown out, plug the vacuum cleaner into the circuit that's inoperative and switch it on. This will help you to locate the bad fuse quickly—especially if the fuse windows are dirty—as the noise from the cleaner will tell you when you've hit the right one



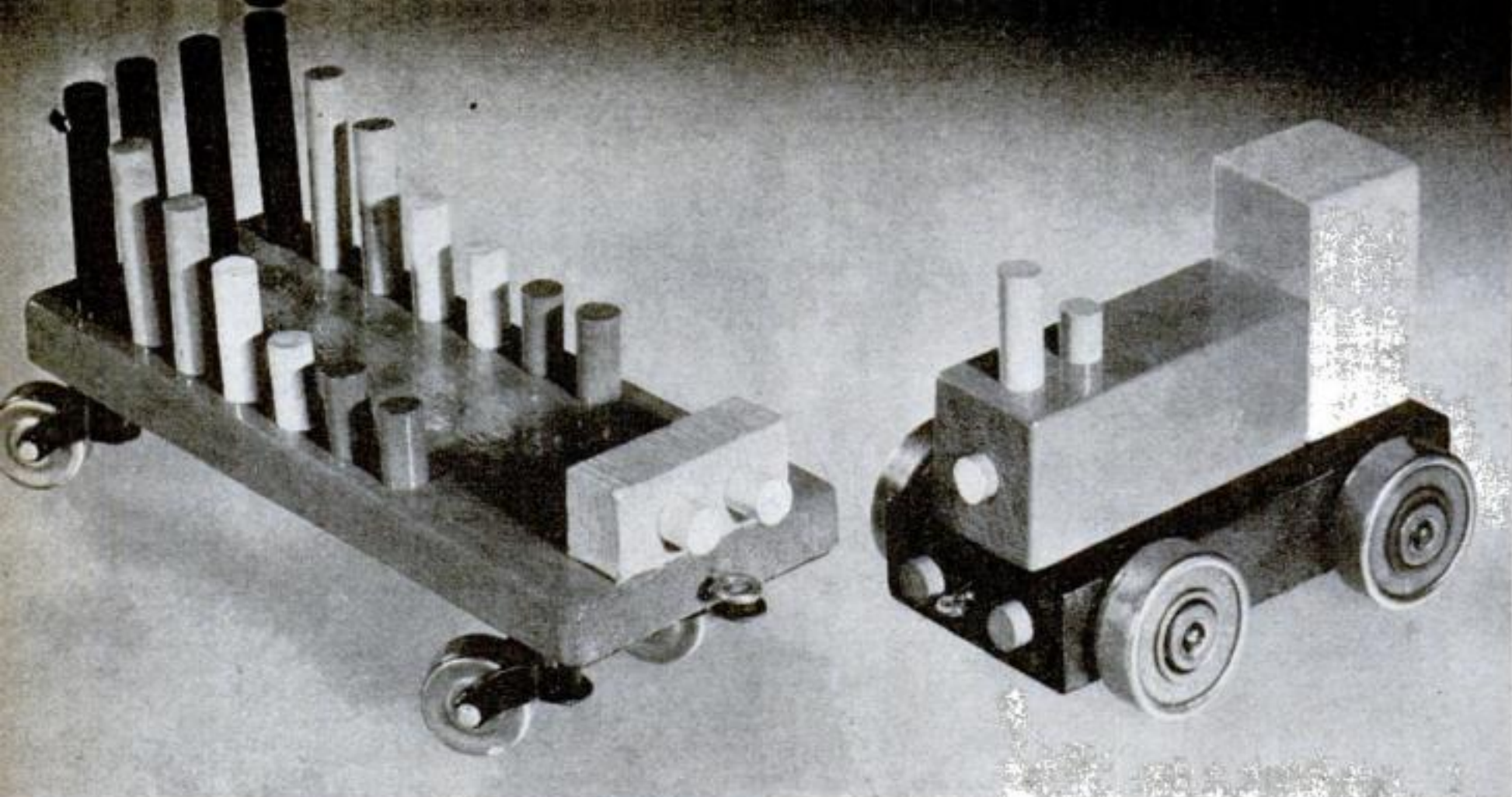
A case stitched from mattress-pad quilting will muffle the sound of a phone bell, and let night-shift workers sleep soundly in daytime



When using friction tape, carry it conveniently. Thread it on a chain having a wire retainer at one end, and loop it on your belt



Household oils bought in bottles rather than squirt cans may be dispensed with a combination screw cap and medicine dropper

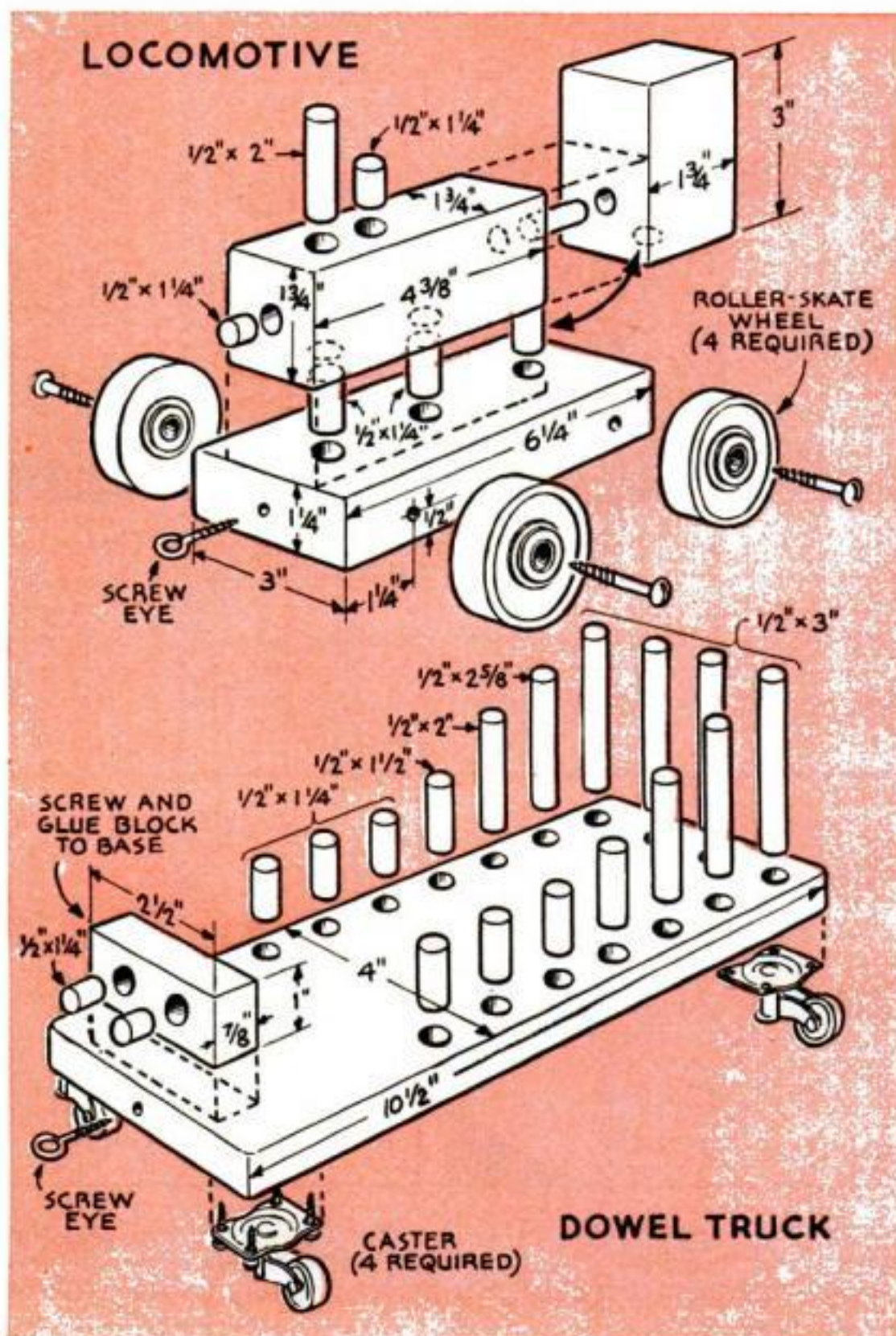


Child's Locomotive and Truck of Loose Dowels and Blocks

SIMPLIFIED construction is the keynote of these sturdy take-apart toys that can be built with three elementary tools—a small saw, a screwdriver, and a hand drill. Three blocks make the locomotive, two of them ordinary 2" by 2" stock, and they are held to each other with loose-fitting $\frac{1}{2}$ " dowels. Bore holes for all dowels with a $\frac{5}{8}$ " bit to allow for a loose fit after painting. Those between the blocks may be spotted to line up properly; but it is easier to clamp the three pieces together and drill three holes from the bottom and one from the back. These holes can then be plugged up with plastic composition wood or small pieces of $\frac{5}{8}$ " dowel. Sand all parts well.

The stick truck is simpler still, consisting of a small board to which a block is glued and screwed from the underside. Space the holes as evenly as possible and saw off dowels of varying lengths, as shown. Wheels for both pieces are exceptionally sturdy, ball-bearing wheels from an old roller skate being used on the locomotive and swivel casters on the truck.

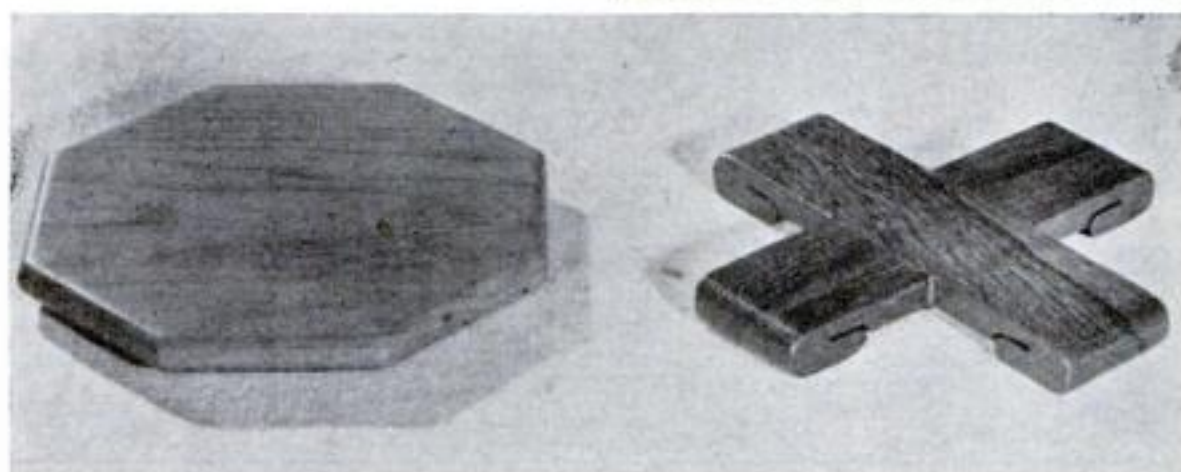
Finish with gay colors like bright red, blue, yellow, and green, which fascinate children. Use nonpoisonous enamel to protect them.—HAROLD GLUCK.



STANDS FOR POTTED PLANTS

Wood, metal, mirrors, and sheet plastic will make better stands for flower pots than runners or pads that retain moisture and spoil the finish of furniture

Geometric forms are among the favorite shapes. Most of them can be made with only a saw and sandpaper. Those shown are of wood, but the one at right has a plastic sheet cemented to it



stand will support and also that there should be air space under the stand to prevent the collection of condensed moisture.

For the traylike stand, a sheet of plywood or other stock may be used. The one shown had sheet plastic glued to the top surface, and the edges were painted.

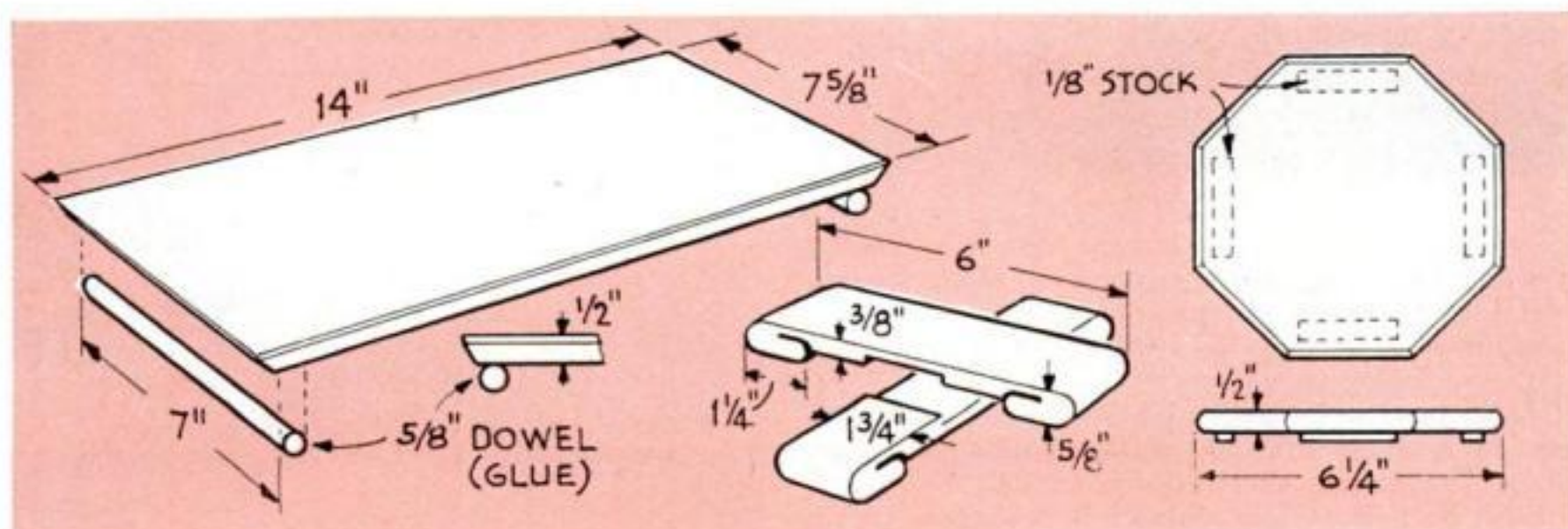
MANY interesting plant stands can be made with little experience from such ordinary materials as blocks of wood, mirrors, and even pie tins. Several examples are shown above, and the details of their construction are given in the drawings below. About the only tool needed to make them is a saw.

The serious craftsman, however, may want to attempt designs of his own. These will be easy if he remembers that size must be in proportion to the size of the plant the

Linoleum might be used, or a finish could be applied to the wood surface. Two lengths of dowel rod form the feet.

The simple cross brace is nothing but an ordinary lap joint. Its feet are shaped Chinese style.

A nicely grained piece of wood makes a fine octagonal stand if varnished so the grain will show. Four rubber-headed tacks or small blocks make the feet. An unframed mirror or a painted pie tin may be used in the same way.—JOSEPH ARONSON.



Good Glued Joints

By EDWIN M. LOVE

MODERN glues provide the home workshop owner with a choice of excellent adhesives for strong wood joints. If he exercises reasonable care, he cannot fail to have success with any of them.

Should glue tests be made? Standard packaged fish, casein, and plastic glues can be accepted without question. Animal glues, usually sold in bulk, are more variable, but a reliable dealer's should be satisfactory. If a sample swells to a jellylike mass without starting to liquefy after prolonged soaking in cold water, and then gives off no offensive odor on being heated, it is probably of good quality.

What clamping pressure is needed? For woods of ordinary densities, 100 to 200 lb. per square inch is sufficient—that is, a minimum of one bar clamp per foot for edge-glued 1" stock. Close-grained hardwoods require greater pressure. Where considerable area is involved, as in face gluing, clamps should be close together.

Leave clamps on overnight, or longer, if possible. Casein and plastic glues require five hours. Some time for seasoning should also be allowed after clamps are removed.

Why are dowels used in glued joints? Although glued joints are often stronger than the wood itself, reinforcements such as dowels, a tongue and groove, or a spline (slip tongue) aid in aligning edge-glued boards.



When model work is being done, or light repairs are being made, gummed paper tape will be found useful in holding small parts or splintered pieces in position after they have been spread with glue.

It helps to make a better job if two joining edges can be brushed with glue at the same time, as at right. The chain, held with bolts and tightened with wedges, is used to clamp this hexagonal piece



Edge joints should show a streak of light along the center caused by a "shrinkage shaving" being taken off to compensate for later end shrinkage. Tight clamping will pull the joint together evenly.



and How to Make Them

They also give extra strength to an imperfect joint, and often make up for lack of sufficient clamping equipment. The value of a long tenon in a corner joint is illustrated in one of the drawings.

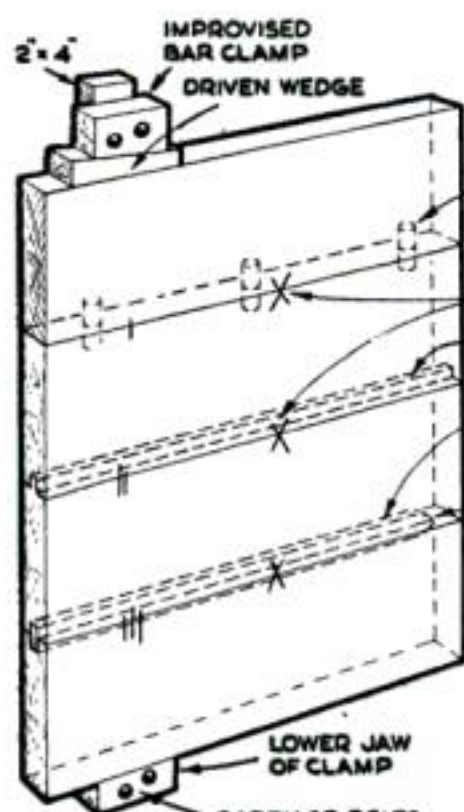
Can end grain be glued? Size end grain with a fairly thin glue mixture. Allow this to dry; then apply a thicker-than-ordinary mixture for final gluing, and clamp with 200 lb. pressure. Since great strength cannot be expected from plain butt joints, scarf the ends, if possible.

How is animal glue prepared? Glue pots for heating are similar to double boilers. A double-compartment photo-chemical can will serve; or a pot may be made from two ordinary cans, one of which is small enough

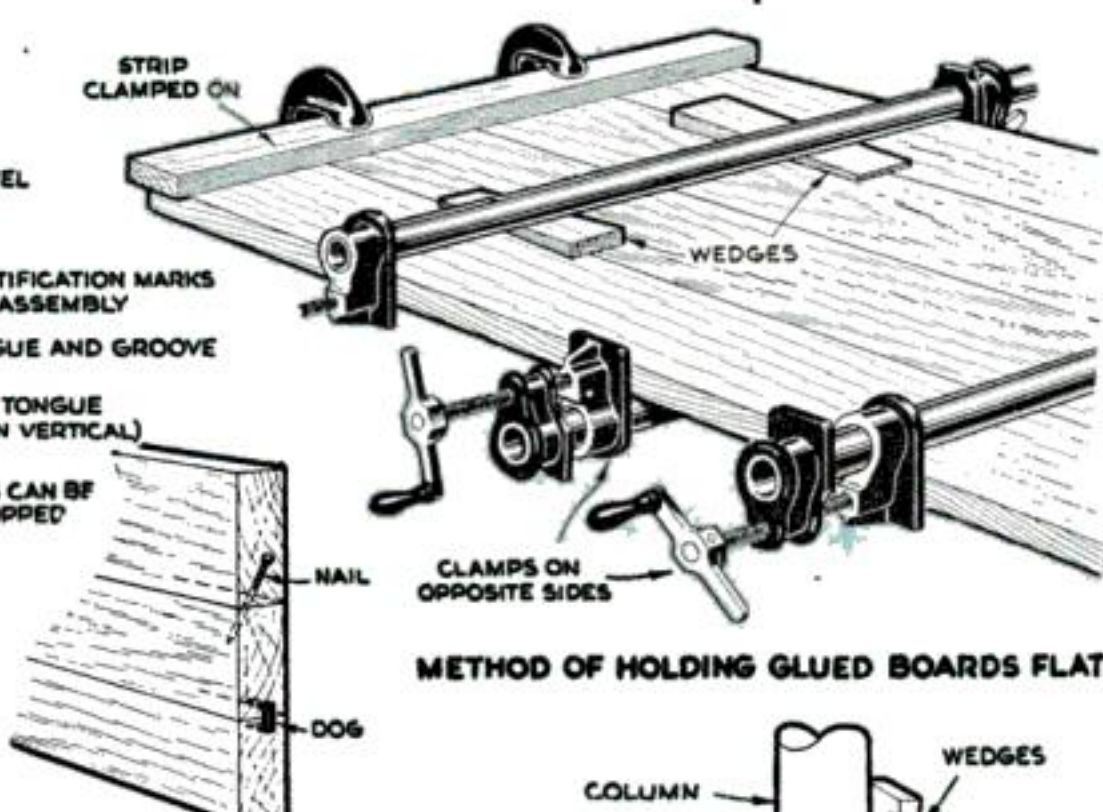
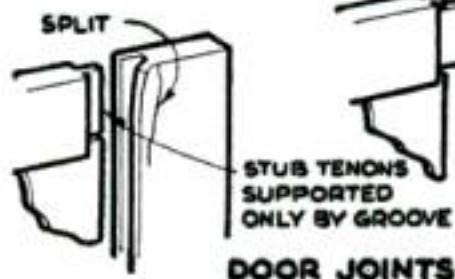
to fit into the other and leave room for water. Cut in the lid of the larger can a hole into which the smaller will fit easily; then cut down the top edge of the small can and bend it down in three or four places to form hanging lugs.

Put glue cakes, flakes, or powder in the top part, cover with water, and soak three to eight hours. Just before using, fill the bottom section with water, heat just enough to liquefy the glue, and hold that temperature until the glue has been used. Stir while preparing, but keep the paddle low in the glue so as not to stir in air bubbles. When ready, the glue should be creamy and should drip from the brush in long strings.

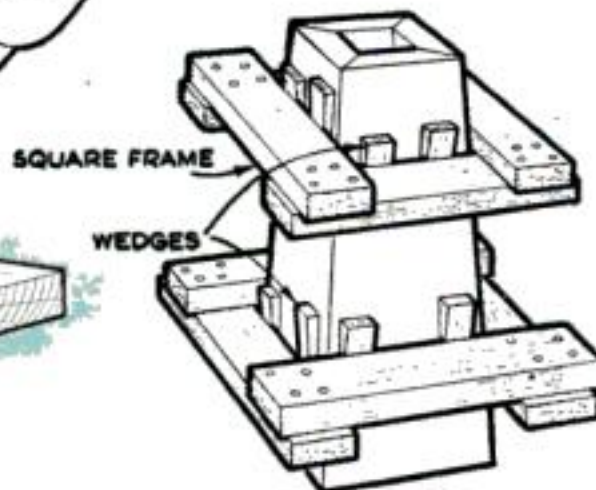
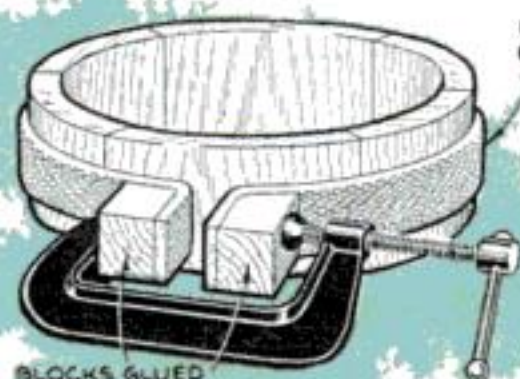
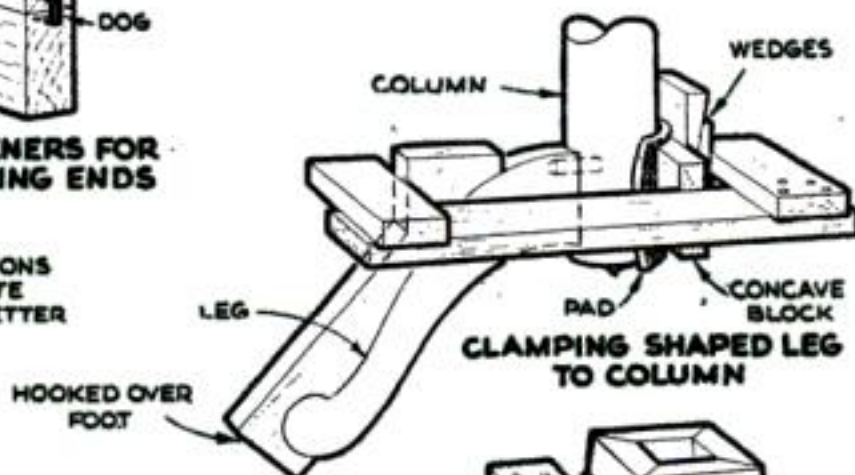
Warm the wood (even for small joints, if



EDGE GLUING



METHOD OF HOLDING GLUED BOARDS FLAT



possible) and have clamps at hand adjusted to fit the work quickly; then brush the glue rapidly on all joining surfaces. Clamp quickly to force the glue into the pores, tightening center clamps first. In face gluing, rub the upper piece lengthwise on the lower three or four times before clamping.

Is fish glue easier to use? It is a ready-to-use liquid that, because of convenience, has largely displaced animal glue. In cold weather, it will help to warm the can in hot water. Haste is not required. Apply glue to both joining surfaces, let them stand for a few minutes, touch up spots where the glue has sunk into the surface, and then clamp.

What is casein glue? It is a white or yellowish powder made from dried skim milk and alkaline chemicals. Mix it in cold water, following the directions on the can. The usual proportions are 1 part glue to 2 parts water by weight, or 1 part loose powder to 1 part water by volume. Mix only enough for the job because the glue becomes leathery and unfit for use after a few hours.

Apply casein glue like liquid fish glue,

taking sufficient time for a careful job. If several joints are to be clamped at once, or other conditions require a lapse of time, lay the glued surfaces together to retard evaporation. All joints should be clamped within 20 minutes after being spread with glue.

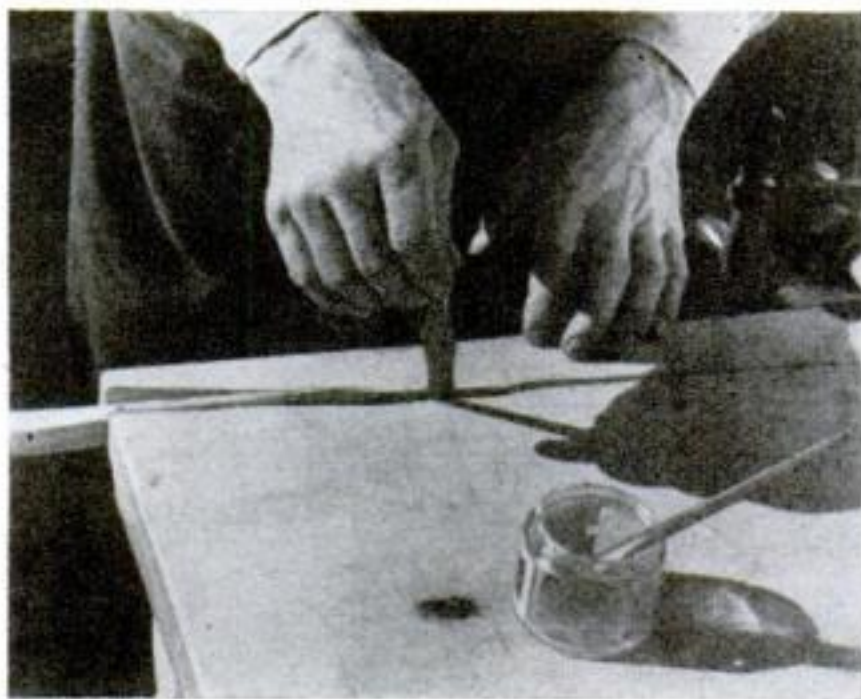
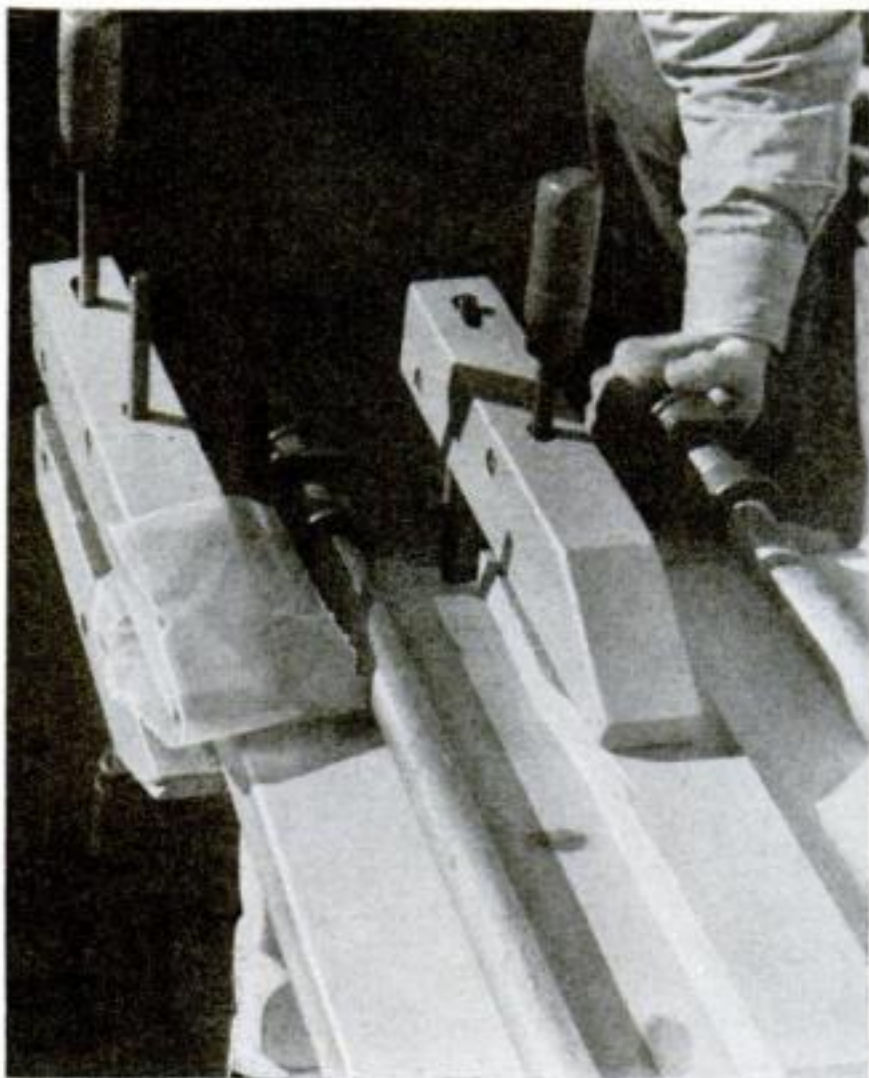
Casein resists heat and water, but it deteriorates when exposed to salt water, and it is attacked by mold. It is satisfactory on almost all woods, but most varieties will stain and may cause trouble with delicate inlays and transparent finishes.

How is plastic glue used? It is a powder to be mixed with cold water according to directions on the container, and used like casein, but a larger quantity can be mixed at one time. The mixed glue lasts about six hours at 70 deg., three hours at 80 deg., an hour and a half at 90 deg., and 45 minutes at 100 deg. Setting the mixture in cold water prolongs its life in hot weather.

Plastic glue is reasonably heat resistant and is waterproof under 150 deg. in fresh and salt water. It does not stain. For veneering and nonwaterproof work, it can be extended by mixing with wheat flour.

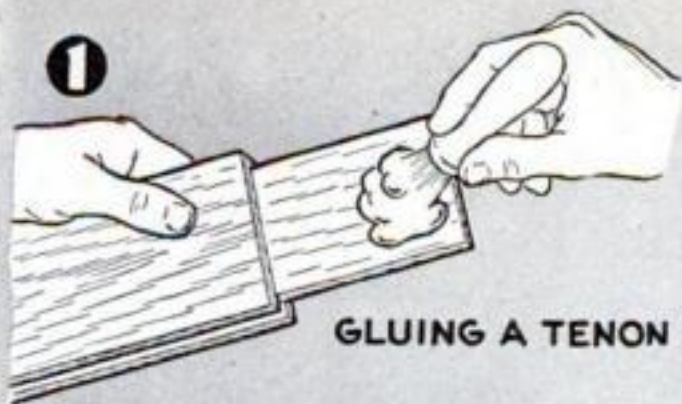
When mending split furniture, use wedges to open the splits a bit in order to let the glue reach all parts; then remove them and clamp the piece firmly. Drive the wedges in below the finished surface to avoid bruising the corners of the split

Before clamping such a split, align the parts with strips of wood clamped on the finished side, as shown below, using waxed paper under the strips to keep them from sticking. Bar clamps usually are satisfactory for pressing the split together

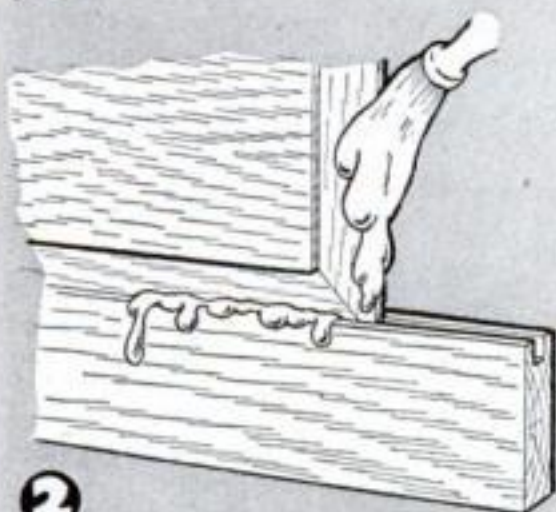


Oval or circular work can be clamped conveniently with a tourniquet of sash cord applied as below. Clamped-on strips keep the cord from slipping off. A tourniquet is useful also in assembling columns

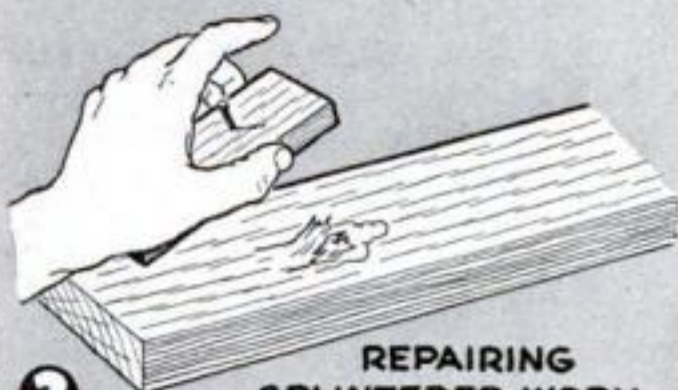




1 GLUING A TENON



2 SETTING IN A PANEL



3 REPAIRING
SPLINTERED WORK



4 PREPARING
ANIMAL GLUE



5 FILLING
CRACKS



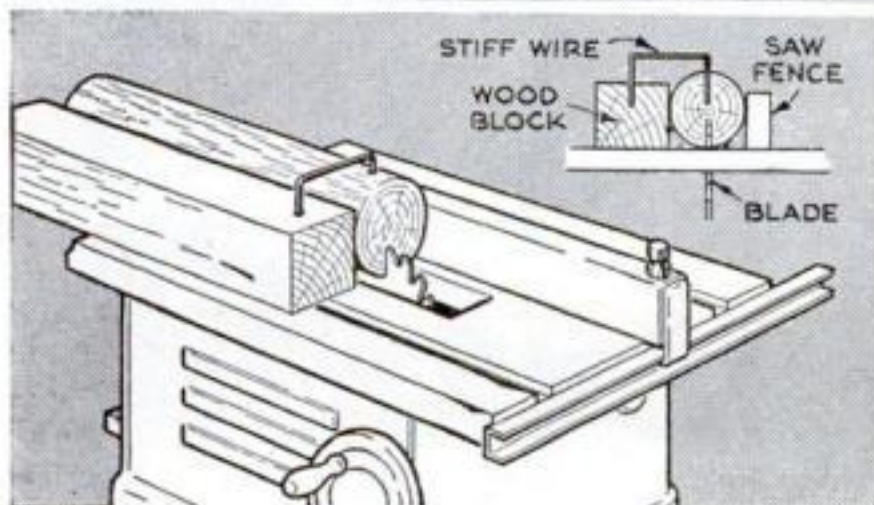
6 MIXING CASEIN GLUE

GLUING ERRORS

ONE serious gluing mistake is illustrated in each of the drawings. If you are expert at gluing, you should be able to spot them immediately. Turn the page over and check your answers with the correct ones given upside down just below.

ANSWERS

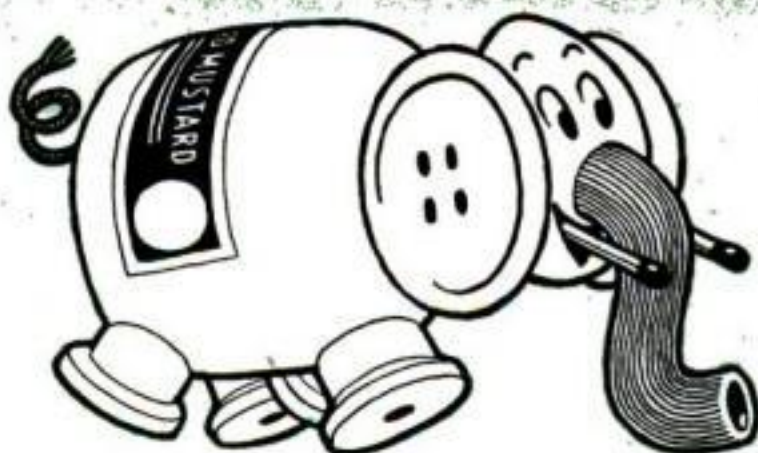
1. Apply glue only to the shoulder area of long tenons. This will let the outer edges slide when shrinking or swelling and will help to keep the shoulder joint tight.
2. Don't glue solid wood panels in grooves. Leave them free to expand and contract.
3. When gluing down a splinter, lay paper, preferably waxed, between the work and the block to keep the block from sticking.
4. Animal glue heated in a dirty pot loses strength. Old glue should be scraped out.
5. Glue is a poor crack filler. In open joints it is likely to break through the finish in beads during damp weather.
6. Mix casein glue only in cold water.



Jig Holds Dowel on Saw Table

WHEN a dowel or other round stock is to be slotted or split into half-round molding, hold the piece against the circular-saw fence with a simple jig consisting of a small block of wood drilled to take one end of a U-shaped wire, as shown. Drill the dowel for the other end—off center, if half-round molding is being made, to leave room for the saw blade.—RICHARD SALZER.

GOOFY ANIMAL CONTEST



\$50 in Prizes for the Best Republican Elephant

First Prize	\$25
Second Prize	\$15
Third Prize	\$5
Five Prizes	\$1 each

THIS is election year and everybody has his own choice for the White House. What's yours? Will it be the Republican elephant or the Democratic donkey? Take your pick and enter POPULAR SCIENCES'S Goofy Animal Contest. It's a way to use your imagination and ingenuity, to have a barrel of fun, and perhaps to win a prize.

All you need to do is to make a goofy elephant or a goofy donkey—the goofier the better. Use any familiar materials about the house—materials like those shown in the photo below, or anything that comes to mind and that will suit your purpose—there is no limit so long as the materials are familiar. When you have hit upon something particularly amusing, send it to us or submit one or two good, clear photos of it. To encourage friendly competition, we will



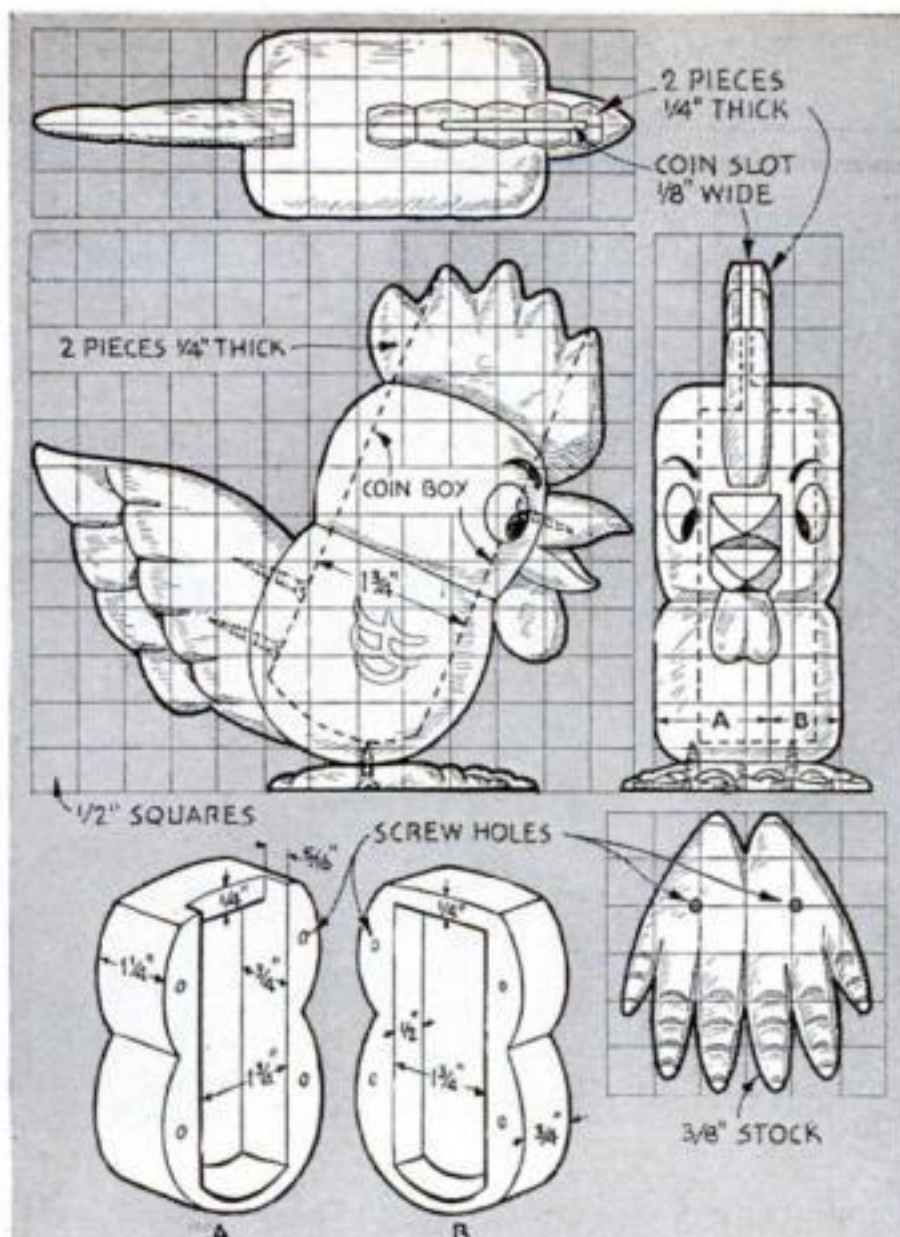
\$50 in Prizes for the Best Democratic Donkey

First Prize	\$25
Second Prize	\$15
Third Prize	\$5
Five Prizes	\$1 each

award 16 prizes totaling \$100—eight for the goofiest elephants and eight for the goofiest donkeys.

No contestant is allowed to submit more than one entry. Size does not count, so if you are going to ship the model itself, keep it small for easy mailing. If you intend to submit photos, make the model any size you please. Mail your entry, fully prepaid, to the Goofy Animal Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York 10, N. Y., to arrive on or before August 15, 1944. No entries will be returned. The judges will be the editors of this magazine, and their decision will be final. In case of ties, each tying contestant will be awarded the prize for which he is tied. The contest is open to all except employees of this magazine.





"Grasping Gimmiebird" Snares Young Children into Saving

THIS perky fellow is really a "Grasping Gimmiebird," and he is so irresistible to children that they will love to feed him coins through a slot in his comb. He is made entirely of wood and can be easily sawed out and carved from scrap pieces.

The body and head are made together in right and left sections of unequal thickness, as shown in the drawing. This makes it easy to recess the center with a chisel to form a compartment for receiving coins. It also allows the box to be opened when it is desired to transfer the money saved to the child's bank account. Removal of the

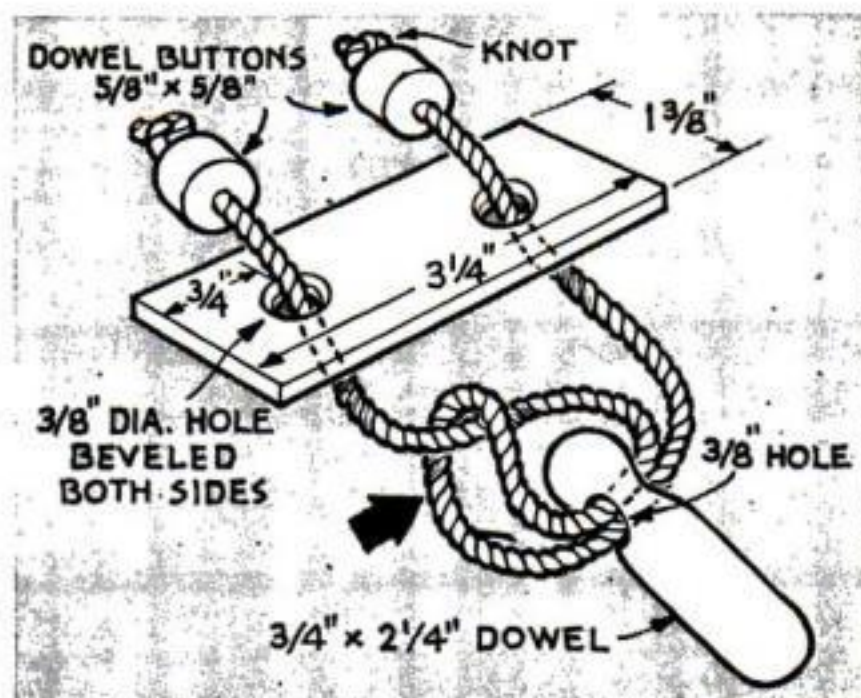
screws in the body and the screw holding the foot to section B releases that section since the beak, comb, and tail are all joined only to part A.

If the comb is made in two halves, it will be easy to chisel out recesses for the coin slot. The two pieces are then glued together, and when dry they are glued to section A. Screws from the inside and glue hold the beak and tail.

Markings for the wings and eyes are applied to the wood with enamel, and the piece is then varnished and waxed, or a full painting job may be done.—ELMA WALTNER.

Loop Puzzle Is a Tantalizer

It's too bad you must be let in on the secret in order to make this loop puzzle, for you would have lots of fun trying to work it out yourself. Push the loop marked with an arrow in the drawing through the nearer of the two holes in the strip, slip it over the corresponding button, pull it back out, and free the peg. This peg is made from a $\frac{3}{4}$ " dowel shaped as shown in the drawing, and short bits of $\frac{5}{8}$ " dowel are drilled to make the buttons at the ends of the cord. Hardwood is used for the strip. About 16" of $\frac{1}{8}$ " cord, arranged as shown in the drawing, completes the puzzle.—G. B.



What's New in Modern Living

ACTION-BACK CLOTHING has been designed for energetic men of the postwar United States. The model coat at the right, featuring a panel back, is the idea of the Merchant Tailors and Designers Association of America. It is a new version that is intended to permit free arm movement and still lie perfectly flat, something that has often been lacking in earlier clothing of a similar type. As will be seen in the photo, the panel is attached to the coat proper only at the shoulders and the waist. Another feature in the clothing designed for after the war is the vest shown in the photo below. A slide-fastener arrangement at each side of the vest allows a 3" adjustment in width at the waistband. This adjustment can be made easily by the wearer without removing the vest. It looks like an excellent idea for the time when rationing is at an end and hearty eating is again customary

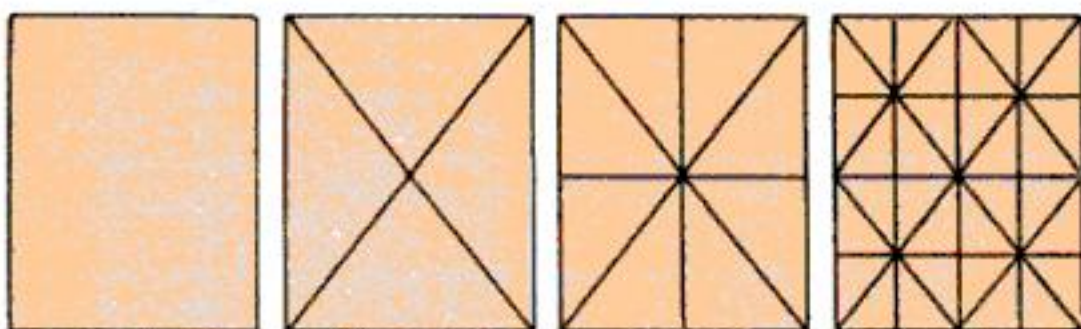
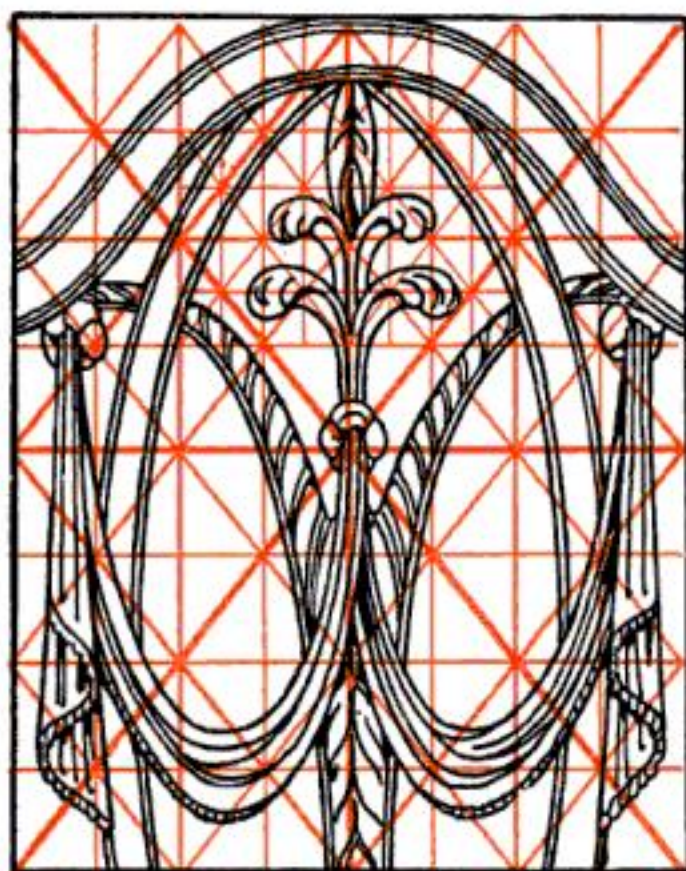


REALLY A HARD NUT TO CRACK, the Brazilian babassu nevertheless yields valuable oils widely used in making soap and margarine and in cooking. Natives of Brazil painstakingly crack this huge palm nut with an ax and a hardwood club in a way similar to that employed by the young lady in the photo, sometimes using 100 blows. When an easy, mechanical method of cracking them is invented, babassus are expected to be a big money crop. In addition to their oils, they have shells that burn with intense heat, can be made into charcoal and coke, and yield important chemicals when distilled

PLASTIC MILITARY BUTTONS NOW, high-color molded-shape civilian buttons tomorrow—this is to be one more use for tough plastics after the war. The buttons shown in the photo below, made by the Plaskon Division of the Libby-Owens-Ford Glass Company, are finished in a wide range of colors, have a hard, nonporous, nonchip, and shatterproof surface, and withstand heavy laundering. Without costly machining, each type is completely uniform



Copying by the Diagonal Method



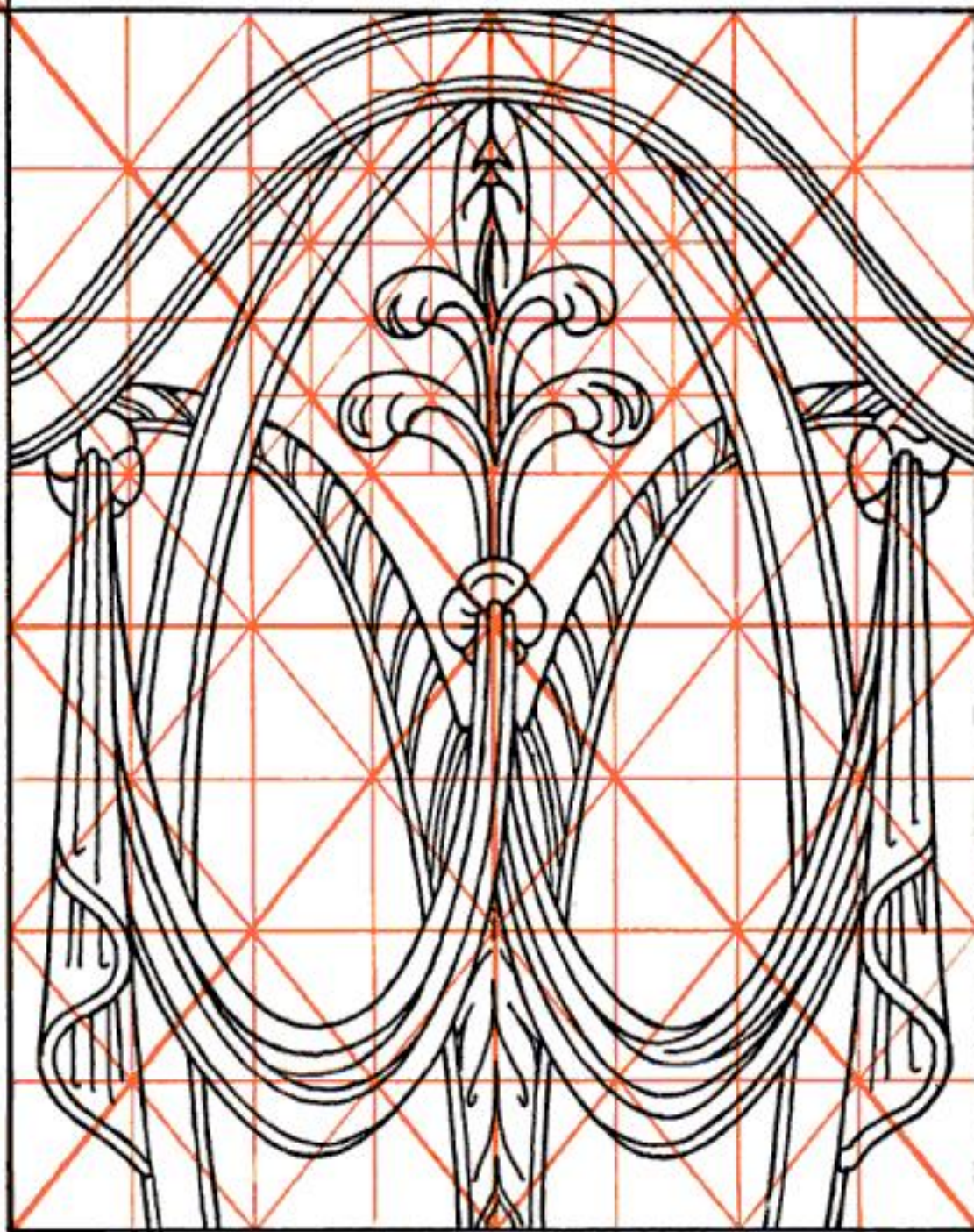
of the original is more complicated than the rest, those sections can be subdivided into still smaller areas. Should it be undesirable to mark the original, draw the co-ordinates on thin tracing paper.

To make a reduced or enlarged reproduction, simply extend the base line and one of the side lines of the original to lengths corresponding to the scale desired, project the diagonal, and continue by drawing vertical, horizontal, and diagonal lines to represent each line in the original.—C. W. B.

IN COPYING, enlarging, and reducing patterns, drawings, maps, and the like, the diagonal method is often found easier and quicker than the more familiar square-up method. The diagonal method is more efficient in that its diagonal, vertical, and horizontal lines intersect and are tangent to a greater number of curved and irregular lines in the original; thus co-ordinates form key locations more frequently, making it easier to transfer points from the original to the copy.

To use the diagonal method, first frame the original matter to be copied as in the first of the four small diagrams at the top of this page, making sure that the corners are square. Next, draw diagonals joining the corners; then draw lines between the centers of the top and bottom lines and the two side lines as in the third diagram. Continue to subdivide the squares and triangles formed by these lines by the same system.

If the detail of some sections



Practical Eraser Shield Made from Discarded Photo Film

IN MAKING erasures on drawings and typescripts a shield is almost indispensable for a clean job. A serviceable one, especially for the person whose work may call for erasures of special curves and shapes, can be made from a piece of discarded photo film.

Wash the negative in hot water to remove the emulsion and cut off a piece of suitable size. Cut openings of various shapes and sizes with a razor blade or very sharp knife, using a paper punch for round holes and the ends of slots.—RONALD EYRICH.



Courtesy Abercrombie & Fitch Co.

Strong, keen blades like these make our soldiers, sailors, and Marines equal to any task at close range

Knives for Fighting Men

By WALTER E. BURTON

WHEN it comes to taking care of themselves in single combat, cutting their way through jungle and Japs on a Pacific island, or doing the swift, silent work of Rangers and patrols in Nazi Europe, our fighting men rely on a heritage from generations of expert woodsmen and Indian fighters—and on the woodsman's weapon, a strong, keen knife. Yet, oddly enough, in our concentration on mechanized warfare and its powerful, deadly weapons, no provision was made in the program for this unpretentious arm.

The necessity for channeling our steel to other war instruments has served as a challenge to American ingenuity. As long ago as December 1942, a call for hunting knives went out from the Army Fourth Air Force at San Francisco, Calif. It became general—both from official military units and from individual fighting men.

By August of last year, boys at the Crozier Technical High School in Dallas, Texas, had made and turned over to the fighting forces more than 900 good combat knives. Individuals, like W. D. Randall, Jr., of Orlando, Fla., who had made hunting knives

for several years, and Frank Jordon, of Akron, Ohio, whose experience dated from cattle days in the Southwest, began turning them out by the scores.

Since priorities for steel used in war work have not included grants for making knives, most of these combat knives have been fashioned from such discarded pieces as old automobile springs, handsaws, butcher knives, and even baby-carriage springs—any good steel that is not too brittle and that is $\frac{1}{8}$ " or so thick and can be hardened and tempered. In Jordon's opinion, at least, files and power-hacksaw blades do not make good knives because their carbon content is too high.

Randall's best-known combat knife is shown at the left in the photo above and in the top drawing on page 153. Jordon's favorite is shown in the series of photos on the following pages and in the drawing on page 152. How Jordon makes his knives is described here for the benefit of home craftsmen who would like to make them.

Those who have supplied knives to the services say that soldiers and Marines prefer a 7" to 8" blade for combat use and for



A SHOP buddy of Frank Jordon's, headed for the Navy, heard that Jap sailors lacked life jackets and often slashed them off Allied seamen.

"If I had a good knife," Jordon's buddy told him, "no Jap monkey would do that to me."

Thus was born a hobby that has kept Jordon, now 50, more than busy in his spare time. In his youth, he made and repaired knives for cattlemen, and once he forged a straight razor from scrap steel. He doesn't charge for his knives—he was in the Navy once himself. They are his contribution to the war.

general utility in the field, while many seamen have been found to lean to a somewhat shorter blade useful for cutting ropes and the like on shipboard as well as for fighting when the need arises. Jordon's knife is a type of dagger with a two-edged blade. Its dimensions are: over-all length, 12"; handle, $\frac{3}{4}$ " thick, 1" wide, $4\frac{1}{2}$ " long; blade, $\frac{1}{8}$ " thick, 1" wide at the guard, $7\frac{1}{2}$ " long. The tang or steel portion of the handle is $\frac{3}{4}$ " wide and 4" long. Use a piece of steel $\frac{1}{8}$ " thick, 1" wide, and $11\frac{1}{2}$ " long.

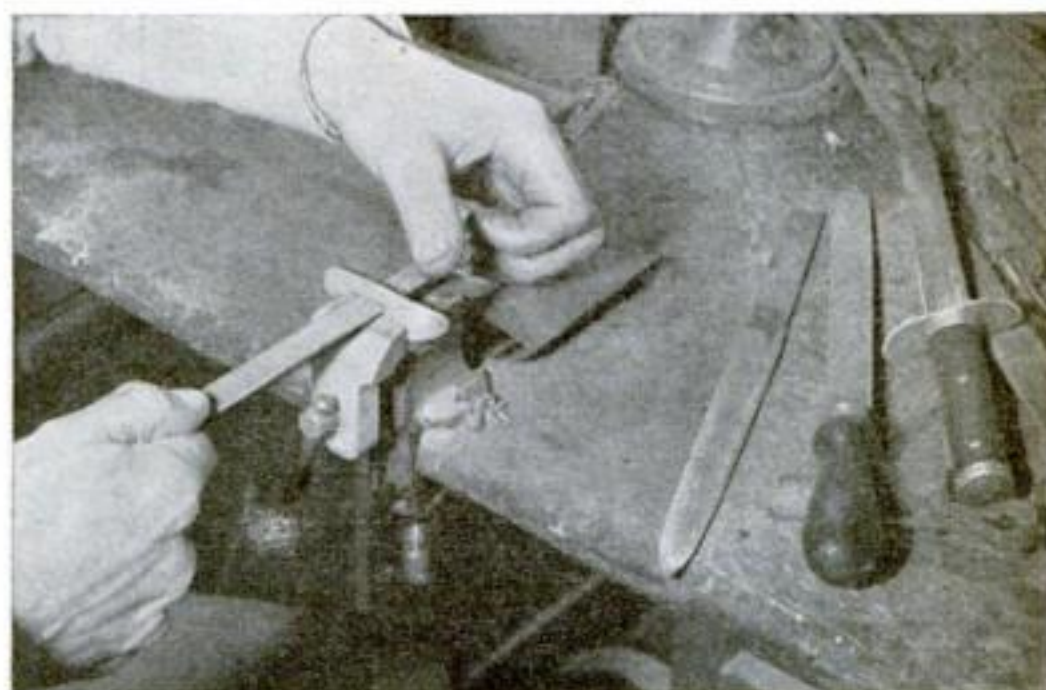
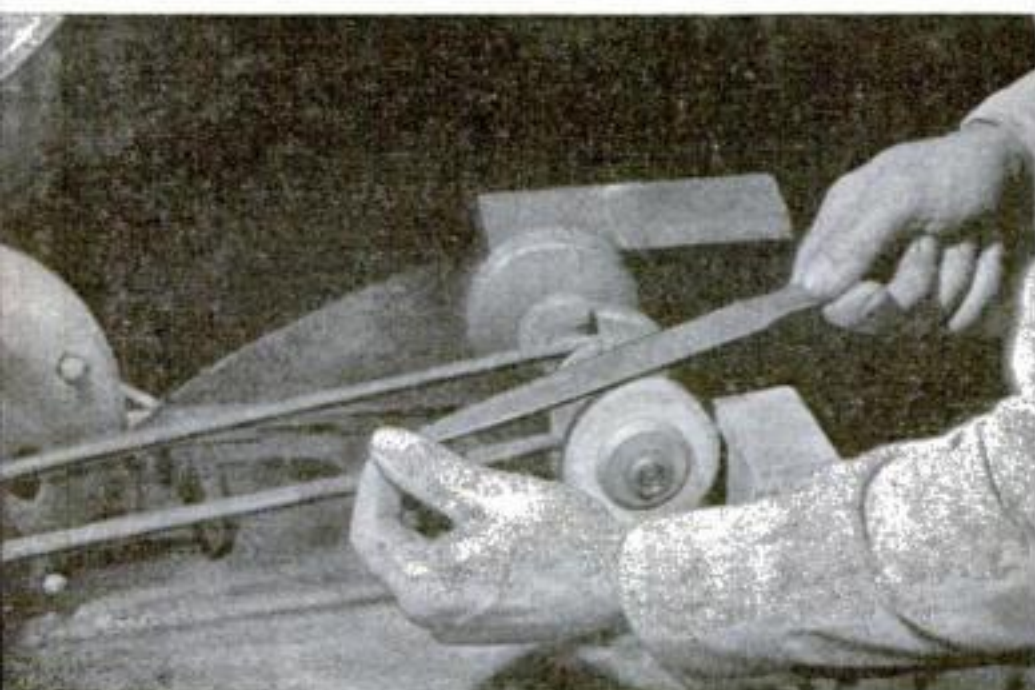
Before making a knife, it is a good idea to test a small piece of the steel by heating it to a cherry red and plunging it into

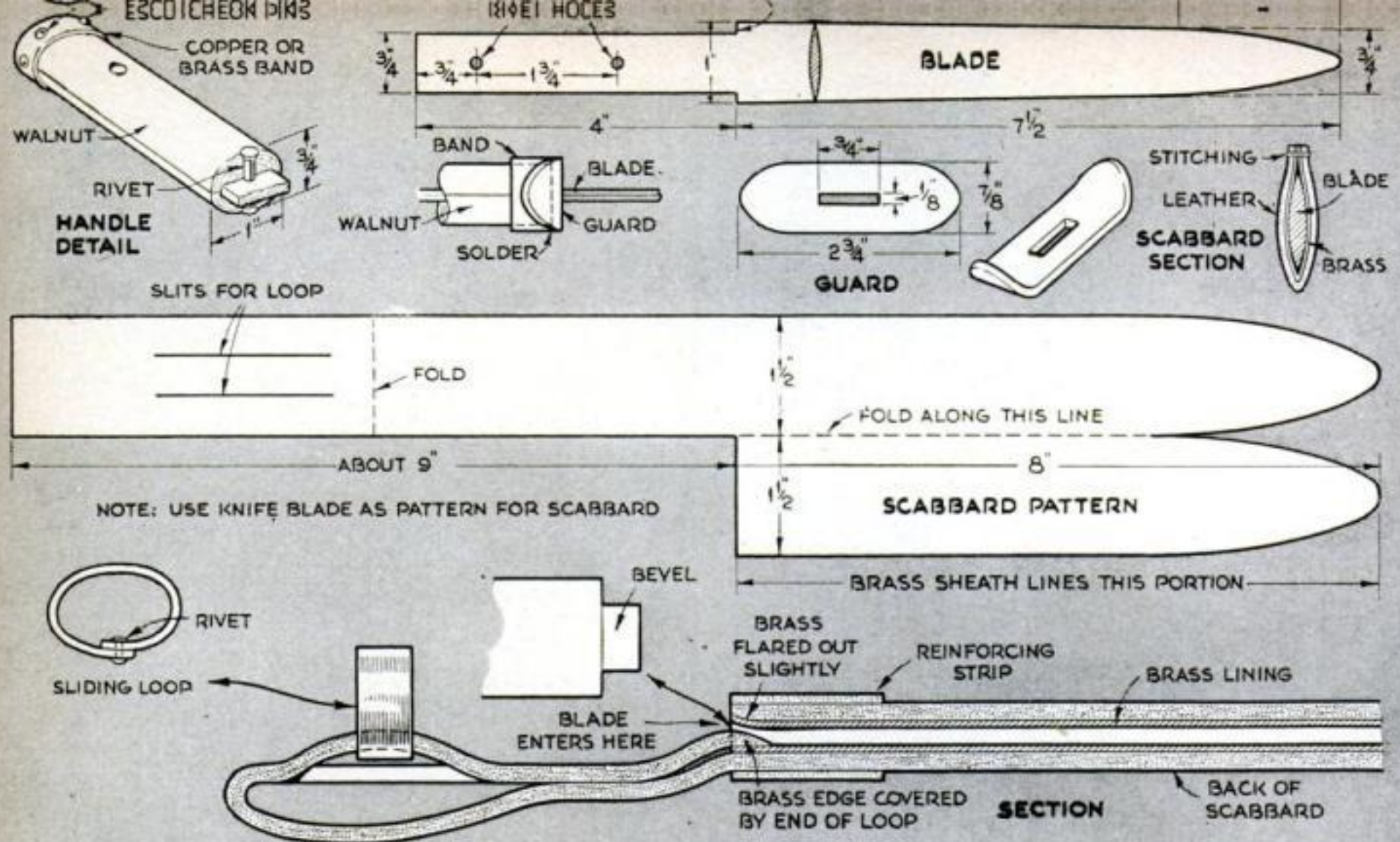
water or oil to see if it will harden. If a file won't bite into it then, it will make a good knife. Steel that has been hardened previously must be annealed to be worked. This may be done by heating it to a cherry red and burying it in slaked lime to cool. The steel is then ground roughly to shape, and final shaping is done with a file. Shoulders $\frac{1}{8}$ " deep at the heel of the blade are produced by filing down for the tang, and two rivet holes are made in the tang.

Next, with the blade in final form and ground to an edge but not sharpened, the steel is heated to a cherry red in a gas flame, bed of coals, or small furnace, and

1 Starting with a $\frac{1}{8}$ " by 1" by $11\frac{1}{2}$ " piece of steel, Jordon grinds it roughly to shape and then carefully files it to final form by hand

2 Brass, stainless steel, or one of the tough alloys is shaped into a guard, slotted to fit the tang, and bent into a curve at the ends





cooled quickly on the surface with quenching oil flowed completely over both sides from an ordinary oil can. This leaves the interior still hot. One side is then polished with abrasive cloth wrapped on a stick so the tempering color can be seen. When the temperature drops to 460 or 470 deg. F., the polished area will be a uniform straw color. The blade is then quickly plunged into oil and left until it is thoroughly cool. If blue patches or other colors show up, the steel must be reheated and the process of obtaining the straw color repeated.

Another method is to heat the steel to cherry redness, quench to room tempera-

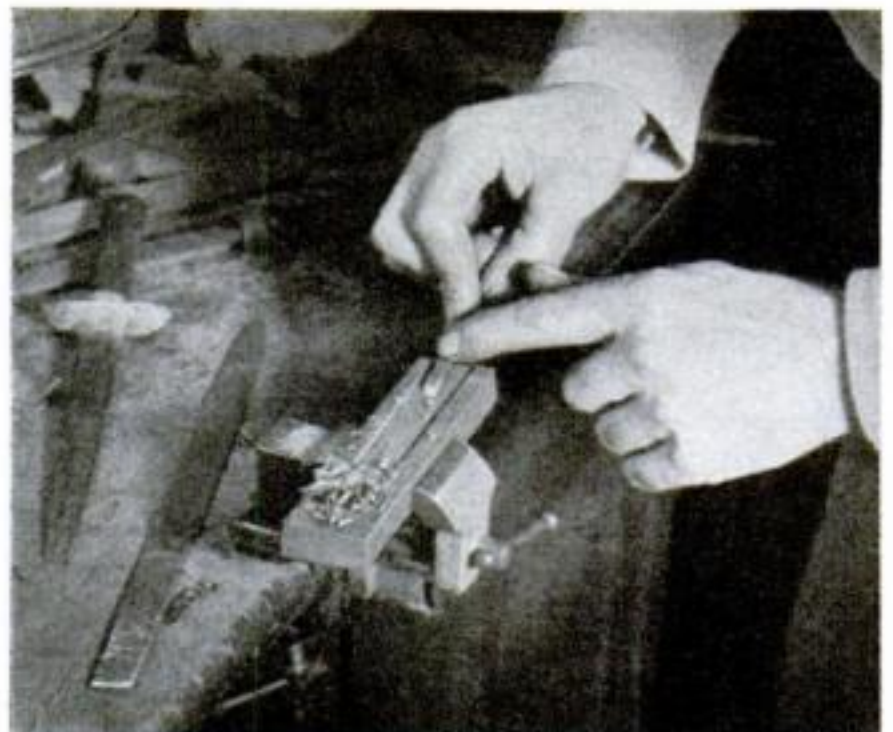
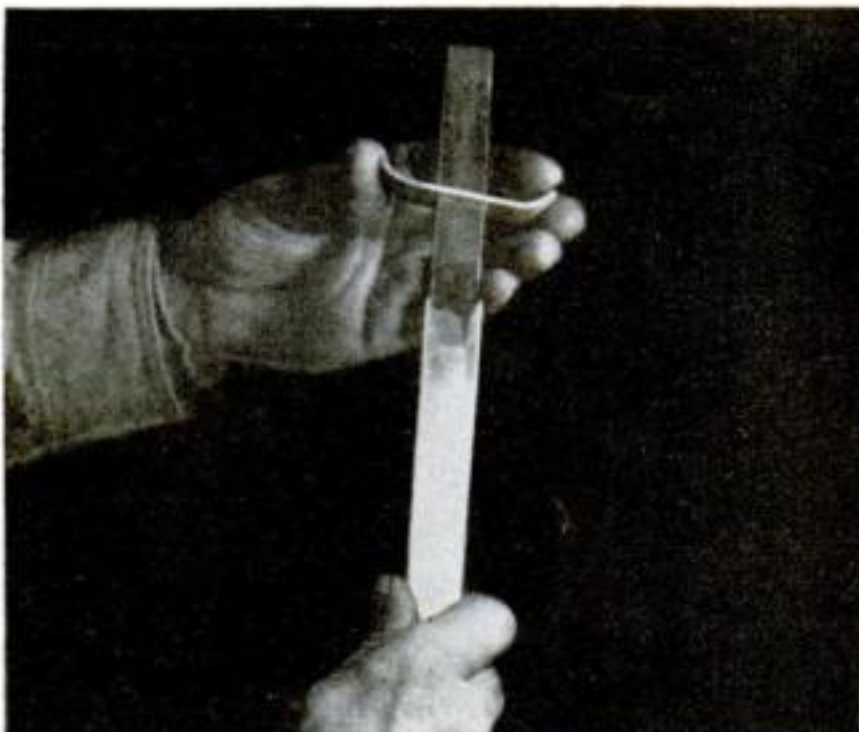
ture in oil, and polish the surface. Then the steel is reheated until the polished area shows the uniform straw color, after which it is cooled in air or is immersed in oil.

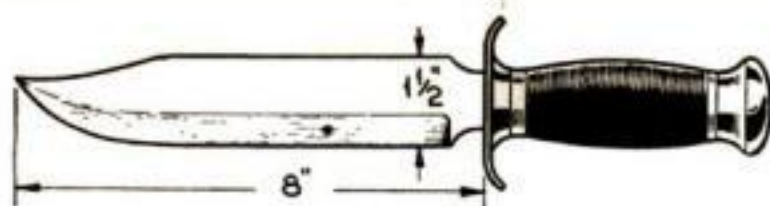
If "cherry-red" heat is puzzling, the steel can be tested with a magnet. When steel is red hot, but not hot enough to harden when quenched, it will respond to a permanent magnet held near it; then when the critical or hardening temperature is reached, the steel loses its magnetic properties. It should be heated a bit longer—10 to 15 deg. hotter if there is an available means of measuring—and then quenched.

A commercial quenching oil can be used,

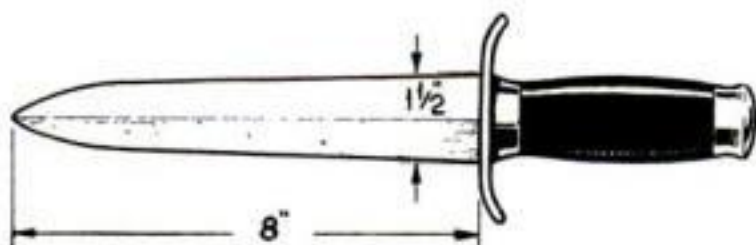
3 Slid on over the tang, the guard fits snugly against the heel of the blade. Its curved ends rest against the thumb and index finger

4 Black walnut from an old table top is cut up into blocks for the handle, which is made in halves, recessed, and riveted over the tang

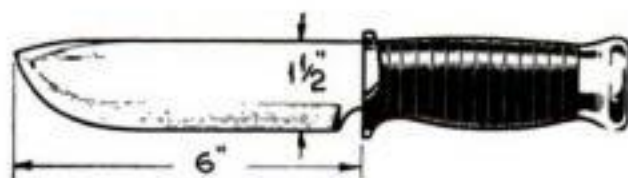




SOLDIER'S AND MARINE'S KNIFE



SOLDIER'S AND MARINE'S KNIFE



SEAMAN'S KNIFE

Courtesy Abercrombie & Fitch Co.

Here are shapes and sizes fighting men ask for. The Army and Marine Corps prefer a 7" to 8" blade that can be used for close fighting, cutting undergrowth, and digging. The Navy likes a sturdy 6" to 7" blade for cutting ropes and other jobs

or a good quenching oil can be made by mixing 2 parts linseed oil with 1 part old engine oil. Engine oil alone also works nicely, but when red-hot steel is plunged into it, it may burn on the surface until smothered. The linseed-engine oil mixture also may burn for a brief time when a very large piece of red-hot steel is immersed in it, but a single knife should cause no more than smoke or perhaps a spurt of flame. Oil produces less brittleness than water does. Jordon prefers sperm oil.

Sheet brass, stainless steel, or a tough alloy will make a strong guard to slip over the tang and rest against the heel of the

blade. It should be about $\frac{1}{8}$ " thick, $\frac{7}{8}$ " wide, and $2\frac{3}{4}$ " long, roughly elliptic in shape, and bent backward at the ends to curve over the thumb and index finger. A slot $\frac{3}{4}$ " long and as wide as the tang is filed in the center.

The simple handle shown can be cut from walnut or other hardwood. Make it in halves and recess the inside of each $\frac{1}{16}$ " by $\frac{3}{4}$ " by 4" to fit over the tang. Each piece should then be whittled roughly to shape for a $\frac{3}{4}$ " by 1" by $4\frac{1}{2}$ " finished handle, glued together over the tang with waterproof glue, riveted with two brass or copper rivets, and finally rasped, filed, and sanded.

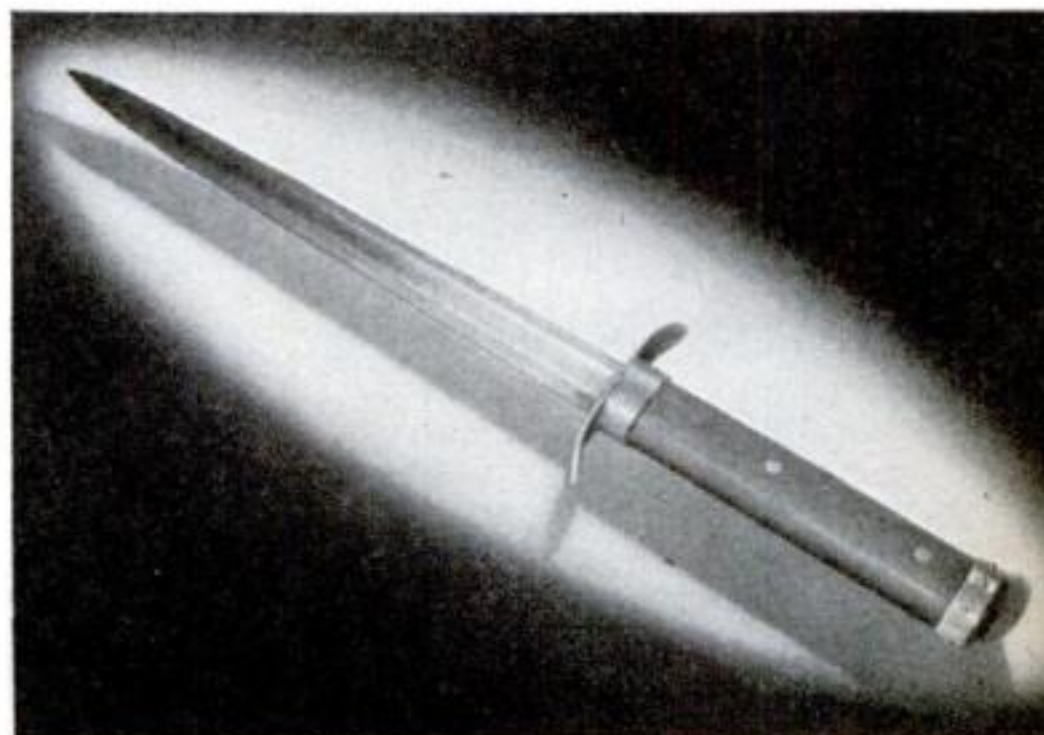
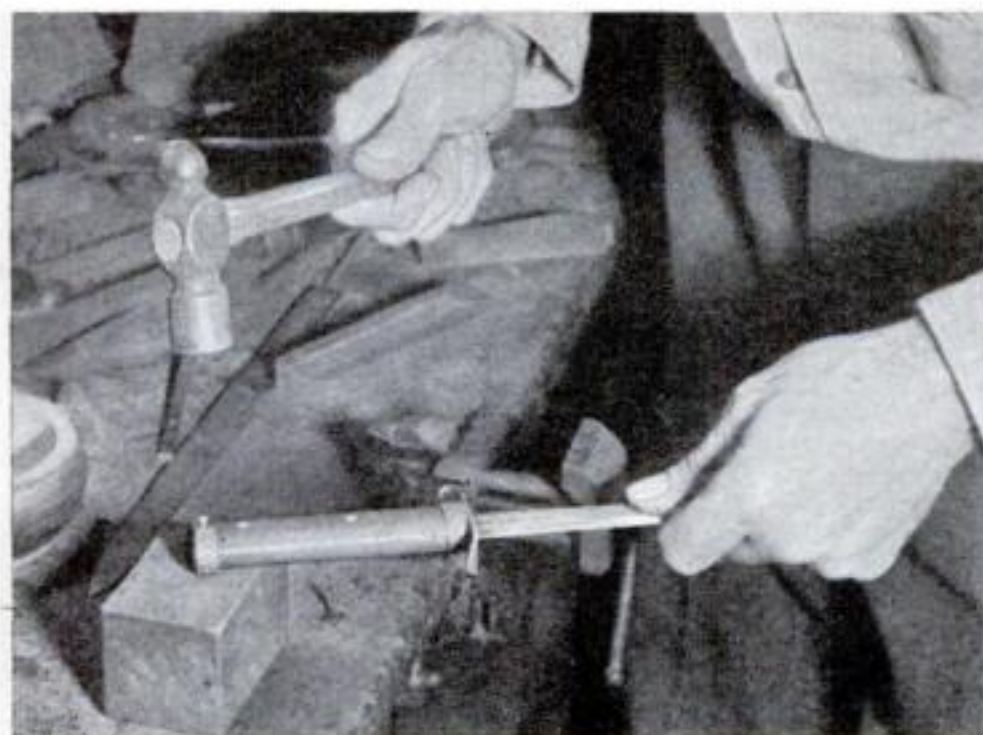
Copper tubing that will be a tight fit for the handle when flattened to an oval is used for the two bands. A $\frac{3}{8}$ " length is cut off and rounded on the inner edges to prevent cutting into the wood; then it is pushed over the handle and driven tight against the guard where it is soldered fast. The second band is cut $\frac{9}{32}$ " wide and driven over the handle until $\frac{1}{16}$ " of the end of the wood shows. Six holes are drilled at equal intervals around this second band, and round-head brass escutcheon pins are driven through them into the wood. Two or more coats of linseed oil, preferably hot, are then applied to the wood for a lasting finish.

The blade is next sharpened by rubbing it over fine abrasive cloth tacked to a wooden block and then honing it on an oilstone.

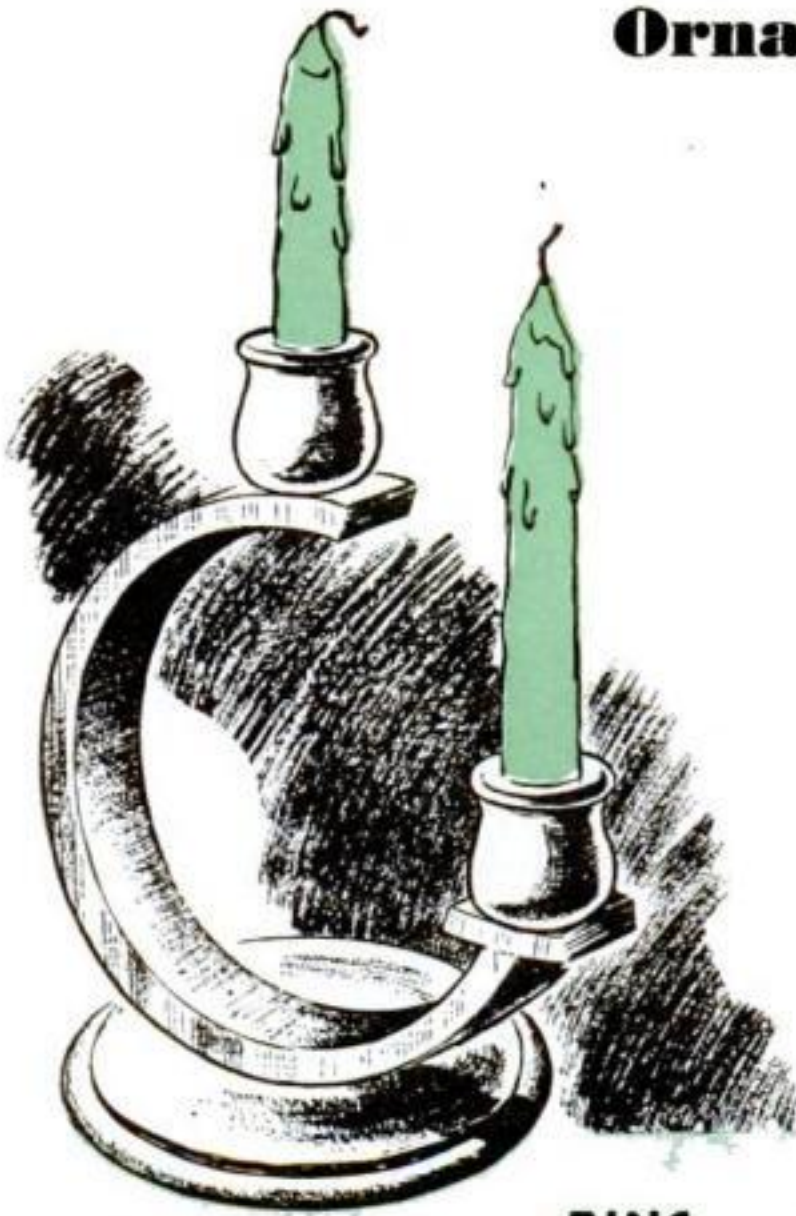
For a scabbard, cut a pattern as indicated in the drawing, using the blade of the knife you have made for obtaining the general outline. A thin strip of brass—such as can be found on an old bedstead—is cut for a lining to fit snugly around the blade without touching the edges. Leather and brass are then folded together and stitched.

5 Copper bands, cut from tubing and flattened into ovals, bind the hilt. One is soldered to the guard and the other is held with pins

6 Here is Jordon's completed knife—strong and sharp, good for hacking jungles, digging fox holes, and puncturing Jap life-belt snatchers



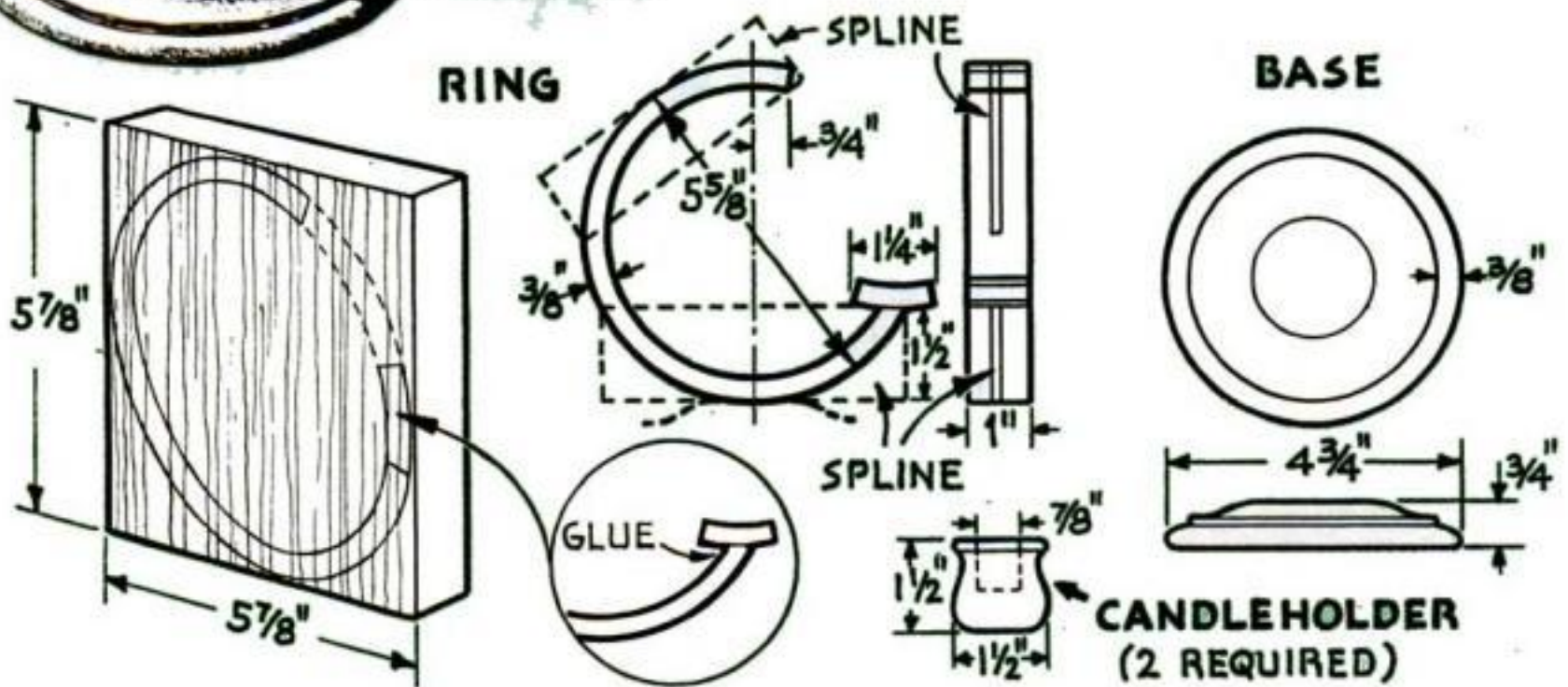
Ornamental Ring Candlesticks



USED to decorate a dinner table or displayed on a mantelpiece, a pair of ring candleholders will add an interesting touch of graceful beauty. Since they are made from short pieces, fine cabinet wood should be used.

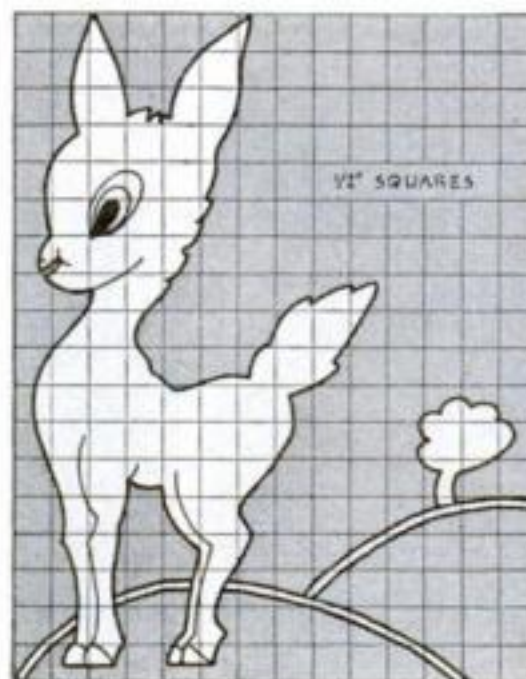
Lay out each ring as shown, noting the direction of the grain. If the ring is then sawed carefully with a coping saw, or a band-saw or jigsaw should these power tools be available, the base can be made from the sawed-out disk. The base shown is turned on the lathe faceplate, but by omitting the shoulder, a nicely rounded modern piece can be made with a rasp, which can also be used to shape the candle receptacles. Candle diameters vary, so measure the type you intend to use before boring the holes to take them.

Cut two splines with the grain from thin stock and set them in the ring to strengthen the end grain at the points indicated. Then dowel the holders on and dowel the ring to the base.—WILLIAM FREEMAN.



Animal Plaque Cut with Penknife Will Decorate Child's Room

LAY out separately on $\frac{1}{4}$ " white pine the designs for a kid or other familiar animal, tree, hill lines, and letters, using 1" squares. Good stock can be found at the ends of orange crates. Have the grain vertical for the animal and tree, and have it horizontal for the hill lines. Cut only on the outside lines, using a sharp penknife. Apply two coats of shellac, sanding well, and paint in the other lines. Make the back from thin plywood, drill for ribbon hangers, and stain. Glue on the figures when dry.—GEORGE BARR.

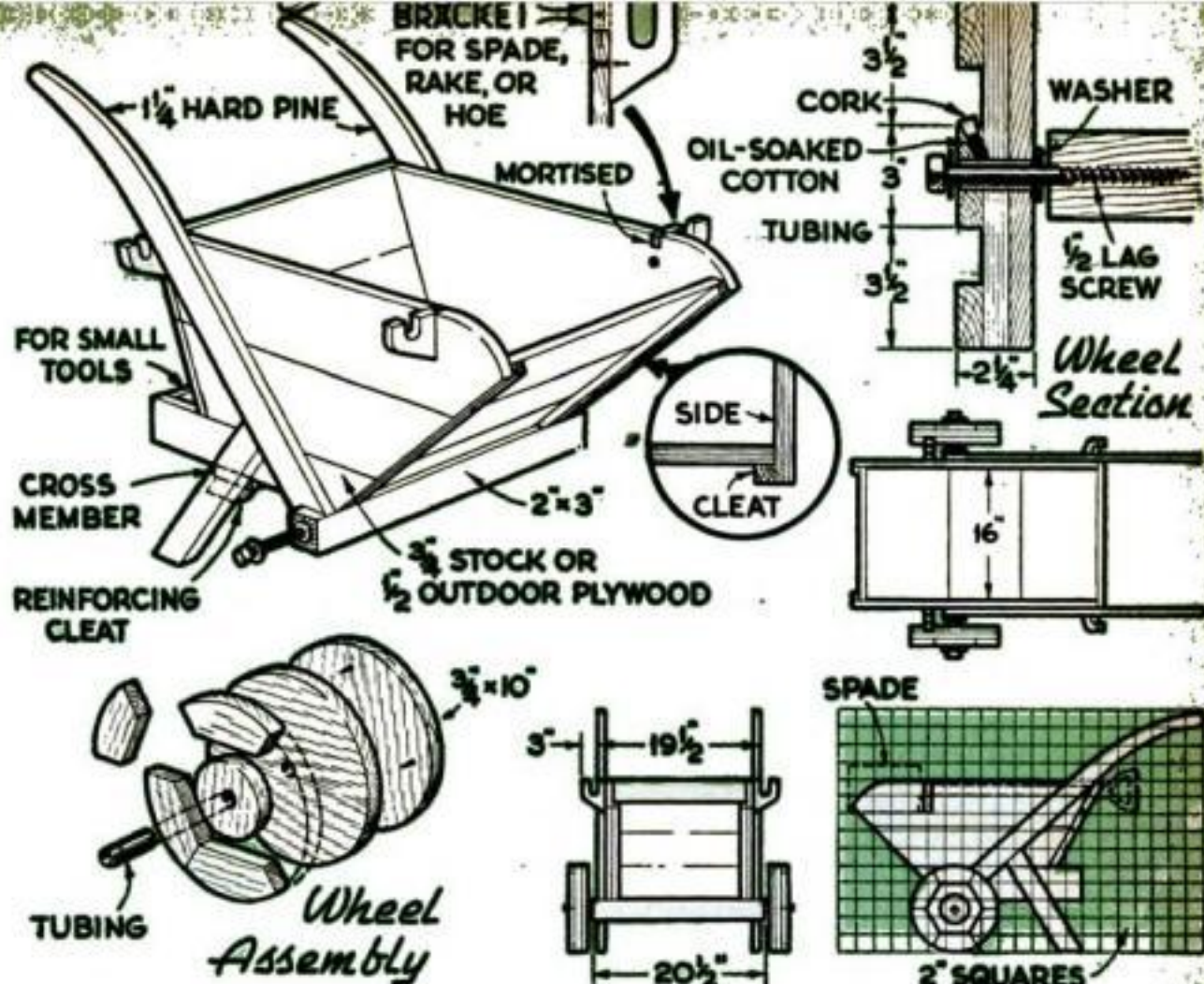




Carryall Lightens Gardening Tasks

LUGGING tools from the garage to the garden can be a tiresome job when your arms are full or you must make two or three trips, but it will be easy with this carryall designed to transport them all in one load and to haul fertilizer and humus as well.

Ordinary materials are used throughout this all-wood project and should be available anywhere since only short lengths are required. The hopper can be made of random-width $\frac{3}{4}$ " pine or $\frac{1}{2}$ " outdoor plywood. Support the bottom on the 2" by 3" axle housing and a cross member resting on cleats between the legs at the back. Make the handles of $1\frac{1}{4}$ " hard pine, jigsawing them to shape out of 5" boards to include the curved end in the same piece.



Brackets are installed on both sides for carrying long-handled tools. Make the notches big enough to accommodate two tools in each. A boxlike "rumble seat" is provided at the back for small tools.

Wheels are made up of hardwood as shown in the drawing. Face the two disks in each wheel with the grain at right angles, and assemble the various parts with glue and screws. Bush the wheels for the lag screws that serve as axles with tubing of suitable diameter. Drill a $\frac{1}{8}$ " hole through hub and bushing; counterbore $\frac{3}{8}$ " for oil-soaked cotton, and plug.—HI SIBLEY.



Saddle Bags Make Bicycle Shopping Easier

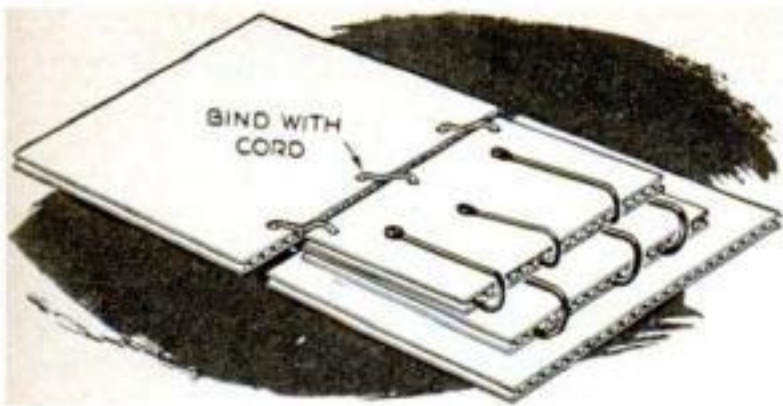
Fully loaded, the bicycle is more stable than with a smaller load on the handle bar

The natural tapering of broomsticks can be utilized in fitting them into the blocks

REMOVABLE baskets can be added to the rear carrier of a bicycle by means of two hardwood blocks attached by wood screws or bolts, as shown in the photographs. Each block has a 1" hole drilled through it in such a way that the holes are on the same level when the bicycle is upright. Two equal lengths of broomstick are inserted into the holes in the blocks. Wooden cleats nailed at the top ends of two ordinary peck baskets fit snugly over the rods.

The baskets are linked together by their handles with a two-ended hook bent from heavy wire. They ride smoothly with no further attachment. Loads of 40 lb. and more can be carried.—J. W. MCFARLANE.



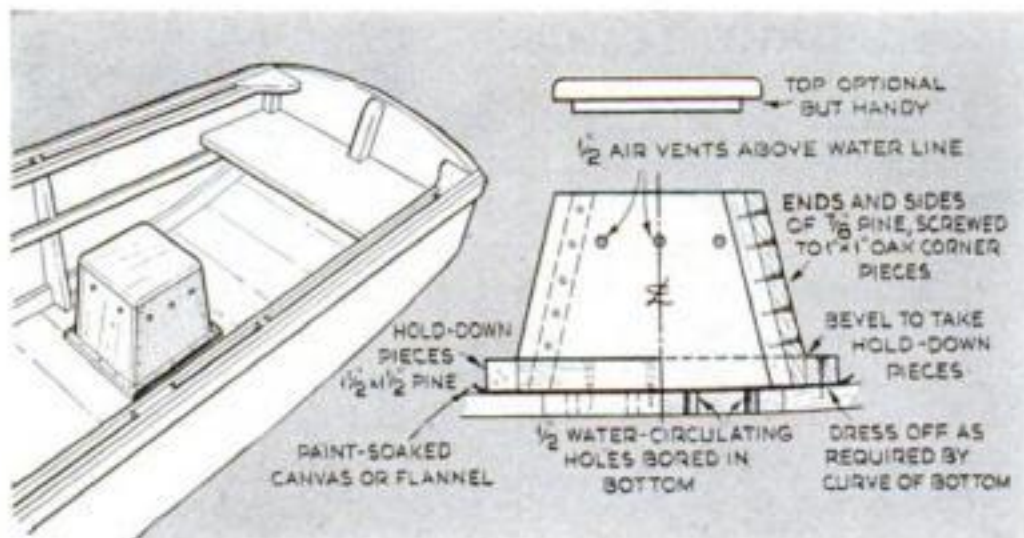


Fishhooks Kept Safely in Cardboard Book

SQUARES of corrugated cardboard into which the sharp ends of fishhooks can be imbedded will make a safe "book" that can be carried with fishing tackle or in a pocket without endangering your fingers. Cut the corrugated leaves and the cover to sizes that will accommodate your hooks with the least bulk, using either corrugated or thinner material for the cover; then bind the book with cord.—FRED CORNELIUS.

Fisherman's Bait Well and Live Box

PINE reinforced by oak corner posts is used in building a bait well and live box designed so it can be removed and the holes plugged when the boat is not being used for fishing. Bevel the bottom portions of the sides and ends, as shown in the drawing below, so they will be perpendicular and fit snugly against hold-down pieces to which they are screwed. The bottom edges of the sides, ends, and hold-down pieces are curved to fit the contour of the flooring so that, when set on strips of paint-soaked canvas or flannel, they will be watertight. Lead all other joints. Bore vents well above the water line.—J. A. EMMETT.



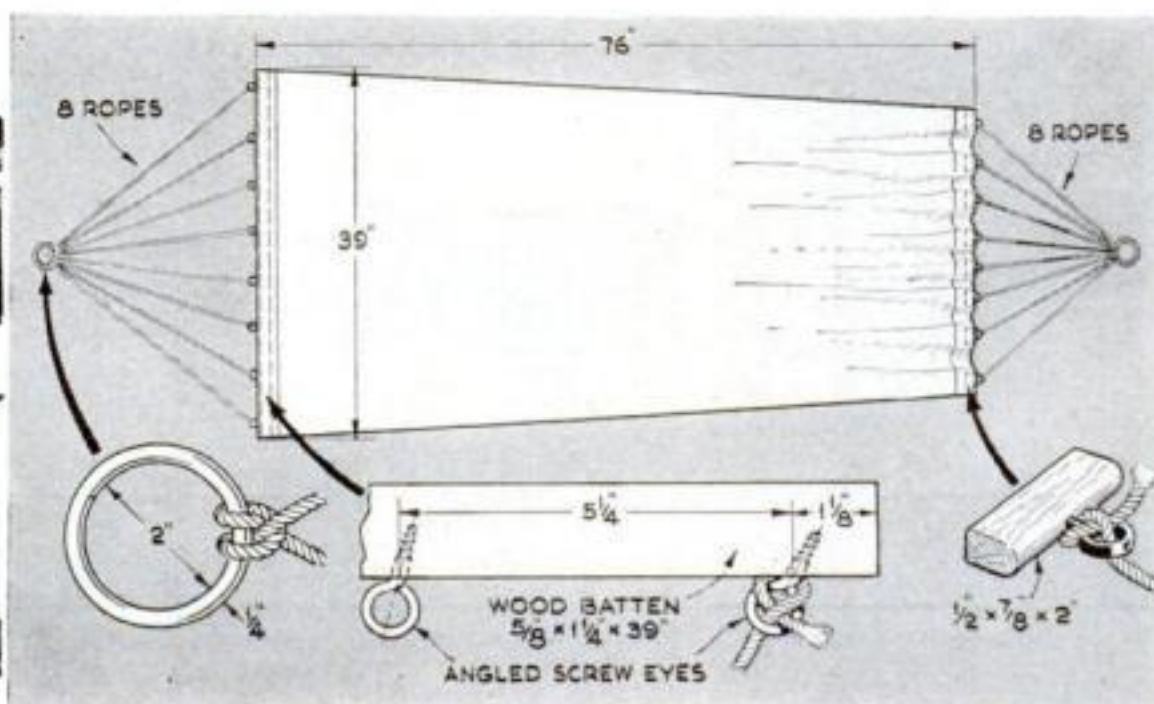
Comfortable Hammock Stitched from Single Length of Canvas

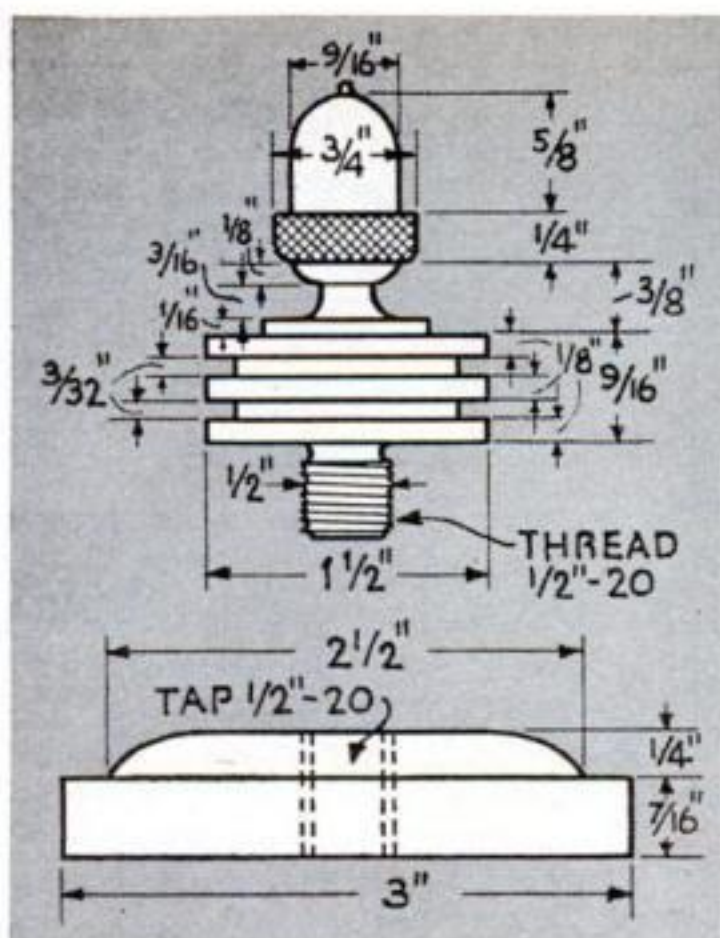
USING a piece of medium-weight canvas less than $2\frac{1}{2}$ yd. long, some scraps of oak or other hardwood, and 41' of $\frac{1}{4}$ " cotton rope, you can make a hammock that will give you many hours of solid comfort. Hem the canvas all the way around, and then make a wide extra hem at each end, double-stitching for strength. Then mark and punch for eight screw eyes in each end, laying out the end holes $\frac{1}{8}$ " from the edges and spacing all of them $5\frac{1}{4}$ " apart.

Drill the top stretcher for the screw eyes, making the holes at an angle toward the center. Cut the $\frac{1}{2}$ " by $\frac{7}{8}$ " stock into eight 2" lengths and drill each for a screw eye.

Round the edges, thread the pieces into the end hems, and insert the eyes.

Cut the rope into two 6', four 5', and two 4' 3" lengths. Whip all ends except one end of each 6' piece. Using the knot and simple hitch shown, attach the four center screw eyes at the head to a 2" galvanized iron ring with two of the 5' pieces of rope, and then attach the four outside eyes with the two 6' lengths, whipping the unwhipped ends when the ropes have been adjusted properly. The eyes at the foot are also attached to a ring in pairs, but the longer ropes are used on the inside so the hammock will have some sag.—WILLIAM H. DAVIS.





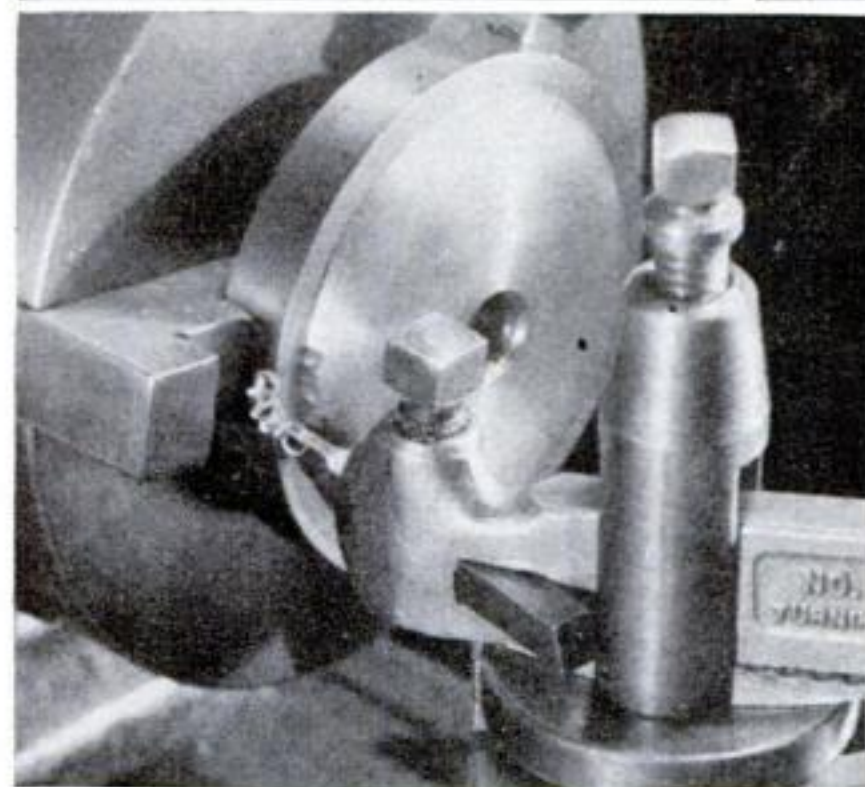
Turned Paperweight Is Easy Lathe Project

NOW and then a leisure evening or two spent in the home workshop turning out some simple but useful article, such as the paperweight shown above, will be welcome rest for tired nerves. This easy-to-build project is designed to utilize short ends or scrap material. The base is made from a steel disk 3" in diameter and about $\frac{3}{4}$ " thick, faced smooth in the lathe on both sides, and turned to the shape indicated in the drawing.

Several different tool bits are used in the operation. The threaded hole is started with a center drill, opened out to $\frac{29}{64}$ " in several easy stages, and finally tapped $\frac{1}{2}$ "-20 with the tap supported by the tailstock center to insure accuracy. Polishing the face is done with fine emery cloth.

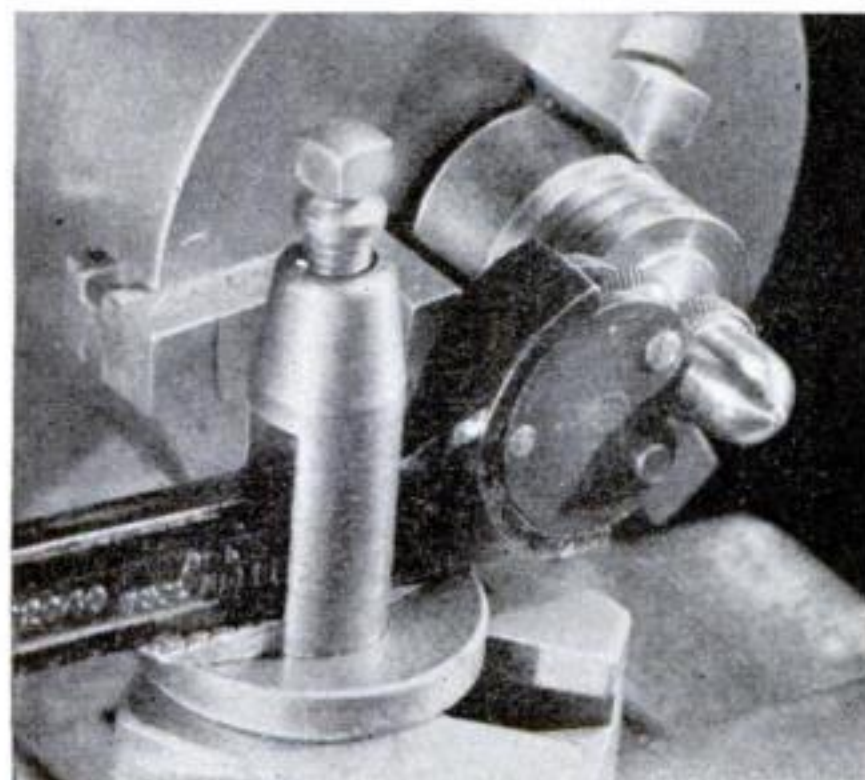
The upper part is turned to the dimensions shown from a short length of $1\frac{1}{2}$ " rod held in the three-jaw chuck, a variety of tool bits also being used, and the piece is polished bright with a fine grade of abrasive cloth. Then the acorn ornament is knurled, with the work and tool well covered with oil and the lathe turning over at slow speed. Sink the knurls deep into the edge of the work and traverse the tool slowly back and forth until a perfect diamond pattern is produced on the full width.

With the piece reversed in the chuck, the short lug is shouldered down to $\frac{1}{2}$ " in diameter and threaded with a $\frac{1}{2}$ "-20 die backed up by a small drill pad mounted in the tailstock spindle and fed to the work by the hand wheel.—C. W. W.

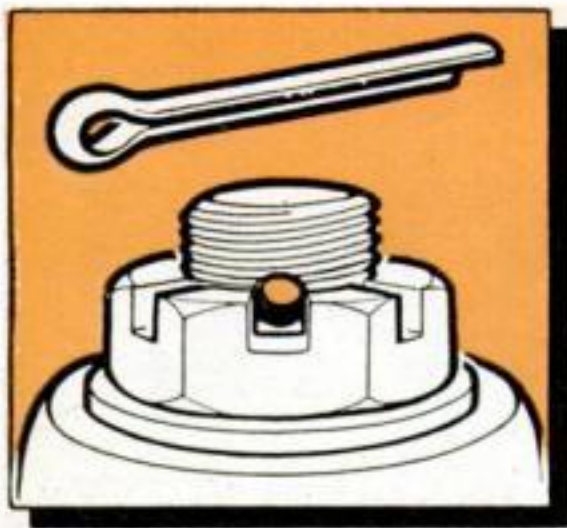


Faced smooth on both sides, the base is turned to shape, drilled, tapped, and polished in the lathe

After completing and polishing the top, knurl the acorn ornament at slow speed, using plenty of oil

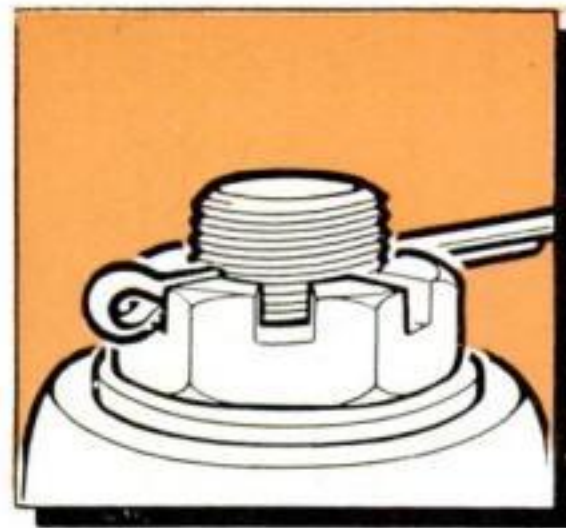


HOW TO "SAFETY" A BOLT



Line up the bolt hole with two slots—below the nut top, level with or above the slot bottom

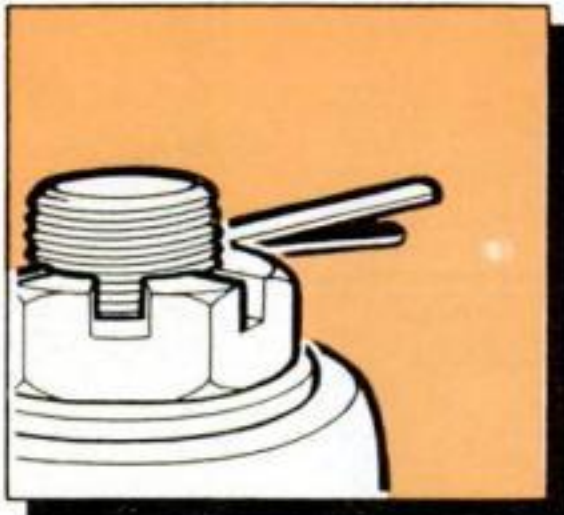
There are several approved methods of fastening nuts with cotter pins. These steps are recommended by Douglas Aircraft Company



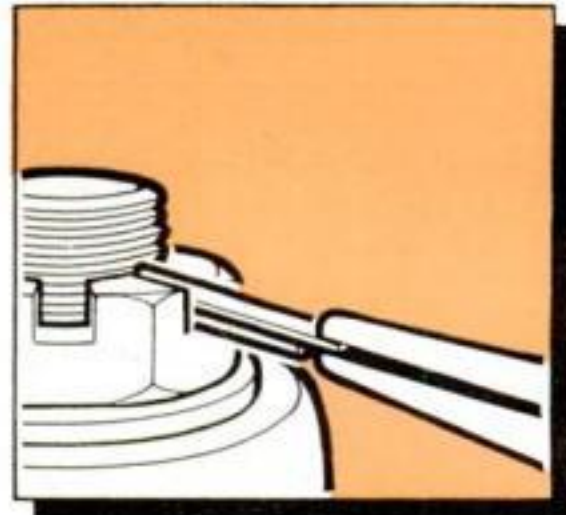
Insert the pin with the longer leg toward the end of the bolt and push it as far as you can



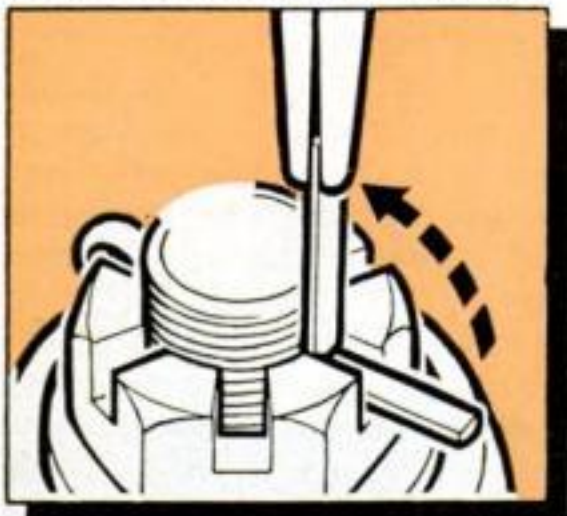
Tap the head gently until it is even with the nut, taking care not to bend it with the hammer



Check again to be sure that the longer leg of the pin is toward the threaded end of your bolt



Then grasp the long leg of the cotter pin firmly with the nose of a pair of pliers, and . . .



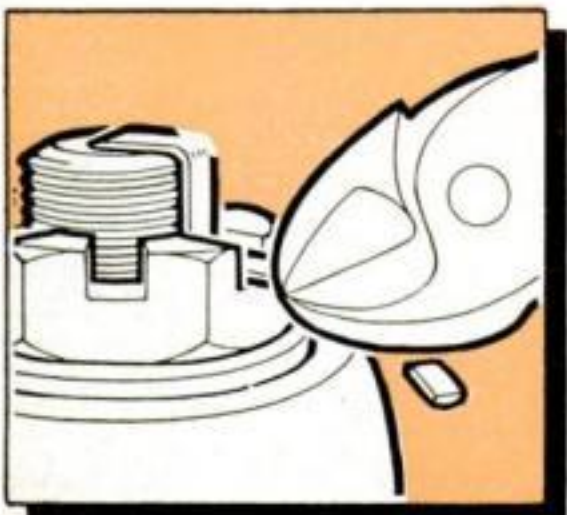
. . . bend the long leg straight upward until it is flat against and parallel to the bolt shank



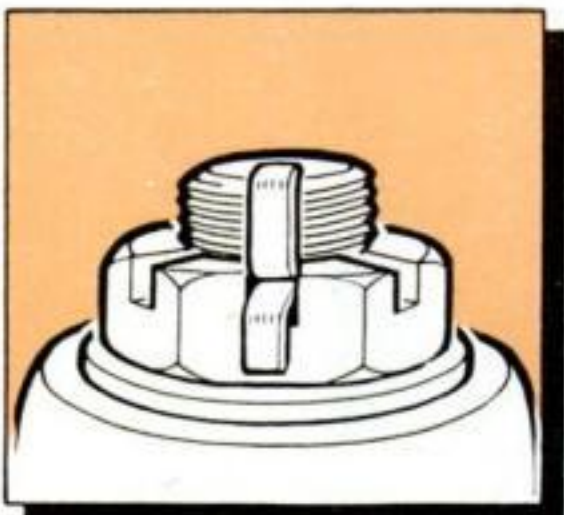
Cut this leg to a length that reaches halfway to two thirds of the way across the bolt end



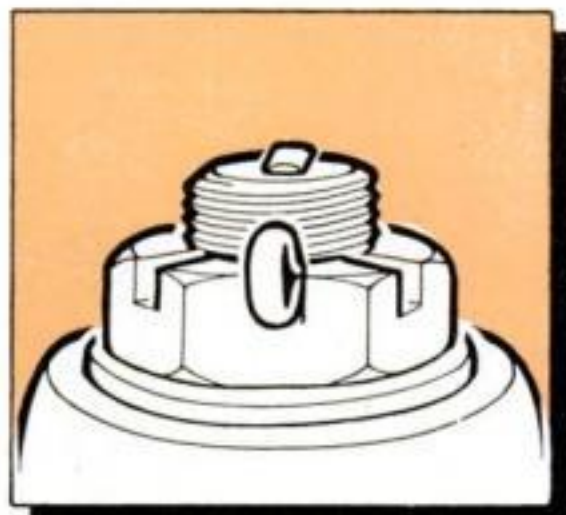
Then bend the cut leg with the hammer by tapping it until it is flat against the end of the bolt



Cut off the other leg with the diagonal cutters so that when it is bent down it will almost, but not quite, touch the washer



Then tap this leg flat against the wall of the nut, as shown here in the completed job. Note the upper leg bent over the top

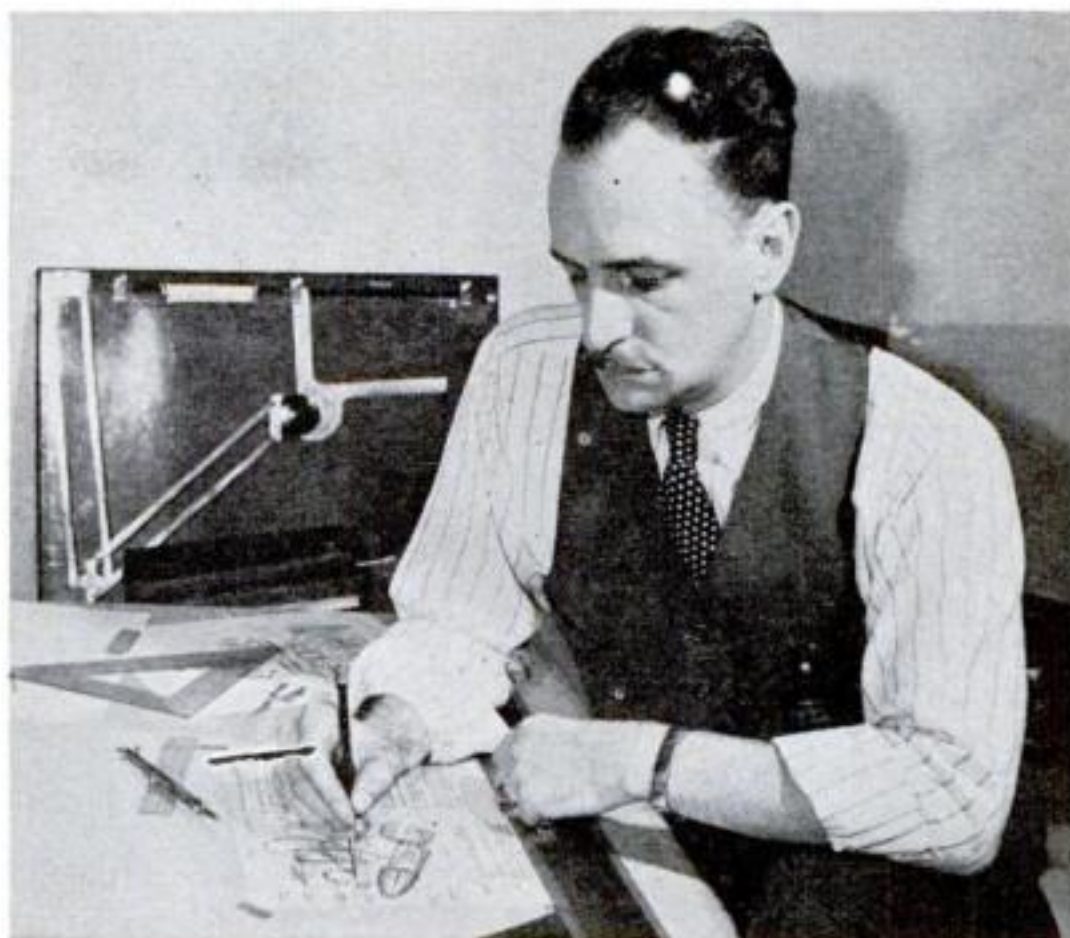


And here is the way a correctly installed pin should look when viewed from the head end. You see part of the bent upper leg

Picture Charts Speed Job Training

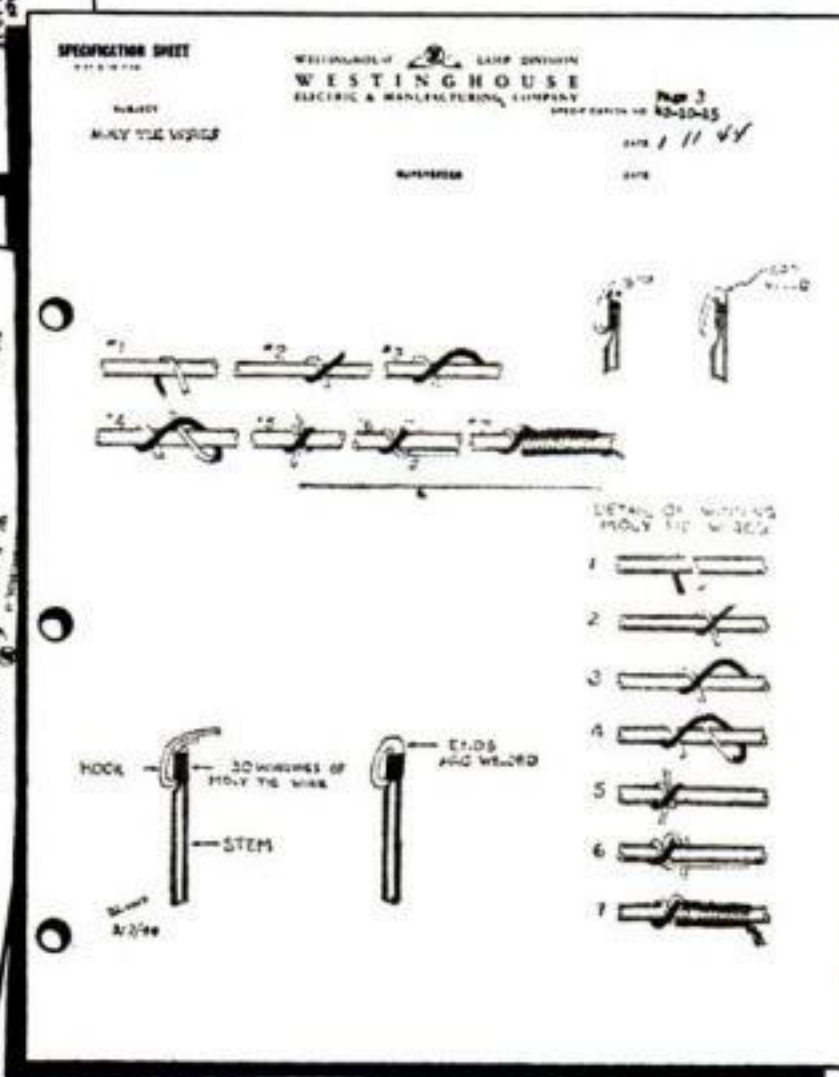
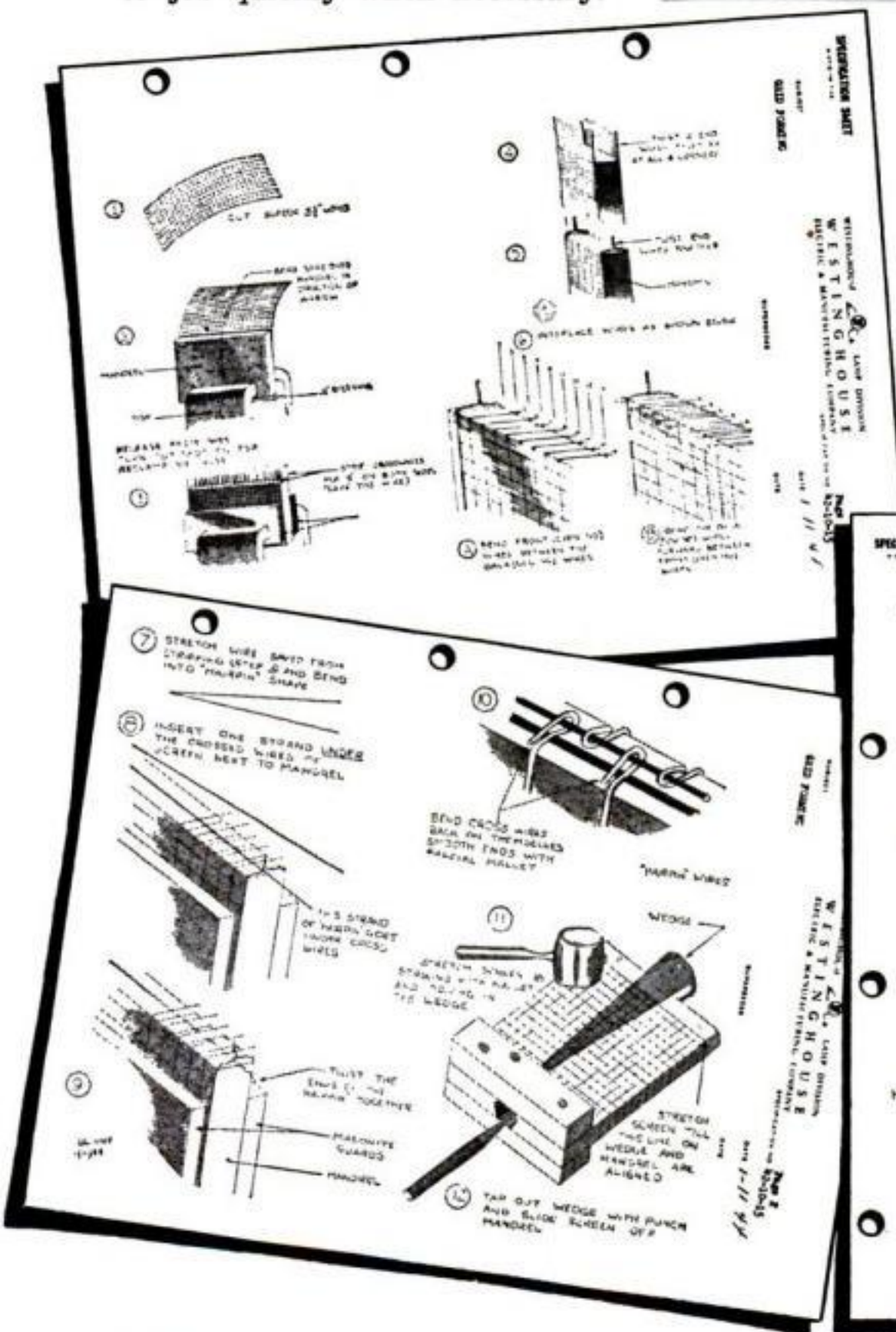
VISUAL-CHART training for the intricate operations in making new tubes and lamps is being used in the electronics laboratory and experimental factory of the Westinghouse Lamp Division at Bloomfield, N. J. These simple, fascinating charts, examples of which are reproduced below, are the work of Walter Lund, who is shown in the photo at right. He worked them out from similar charts he used when he was an instructor for a correspondence school.

Immediate results have been a reduction in rejections, instant instruction that frees foremen for more important work, and a system that makes it possible to shift workers from job to job quickly when necessary.



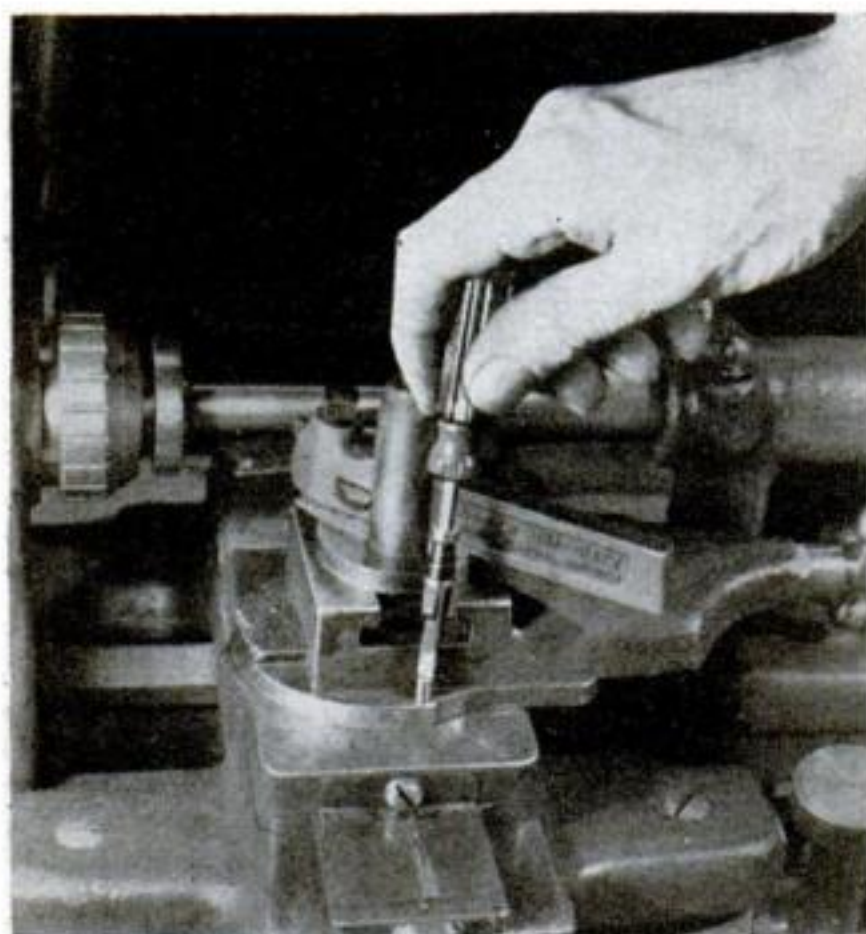
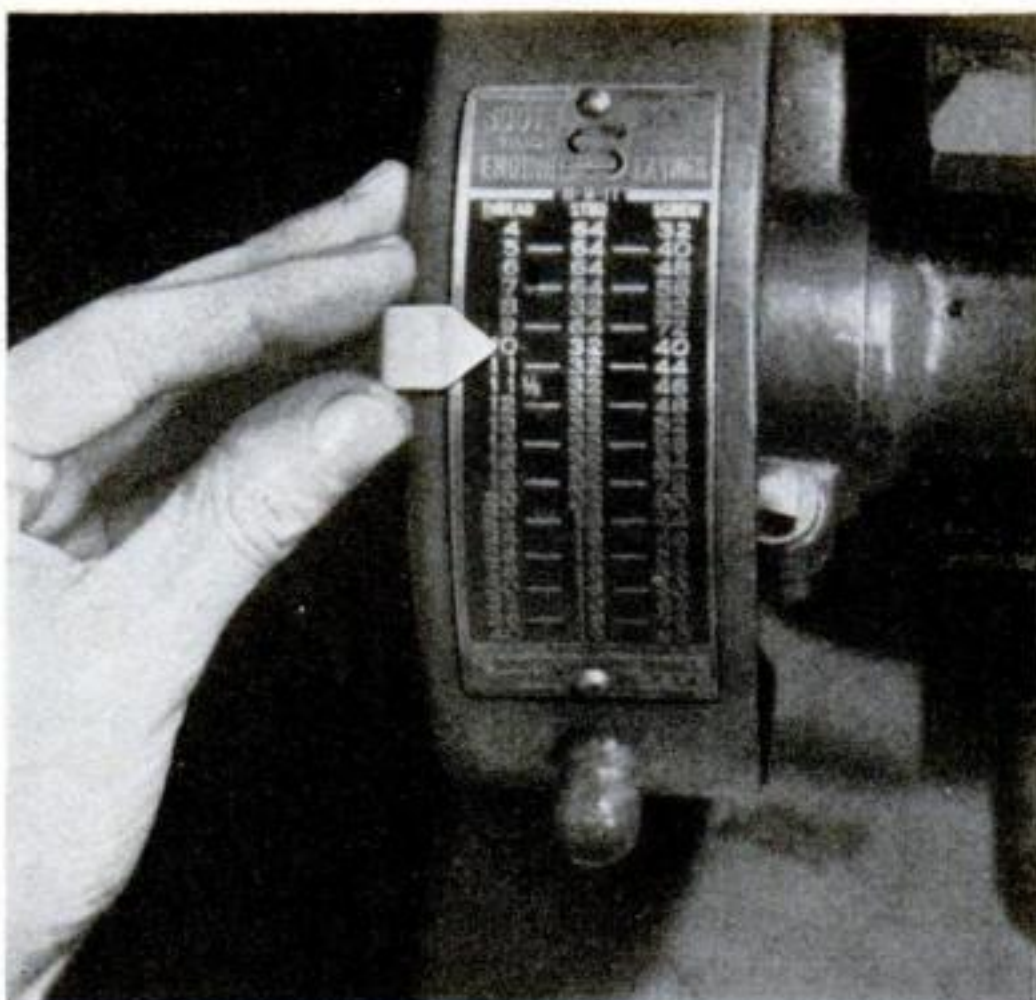
All steps in grid forming are shown with graphic simplicity in the two-page chart at left. Before this was drawn up for the instruction of Westinghouse workers, rejections of grids were at a high rate

Below, an example of how visual charts can be improved. Both details of the step-by-step winding of molybdenum tie wires were worked out by Walter Lund—that on the upper half of the page first. Then Lund experimented with the position of the pictures and found instructions much easier to follow in a vertical row



NEW SHOP IDEAS

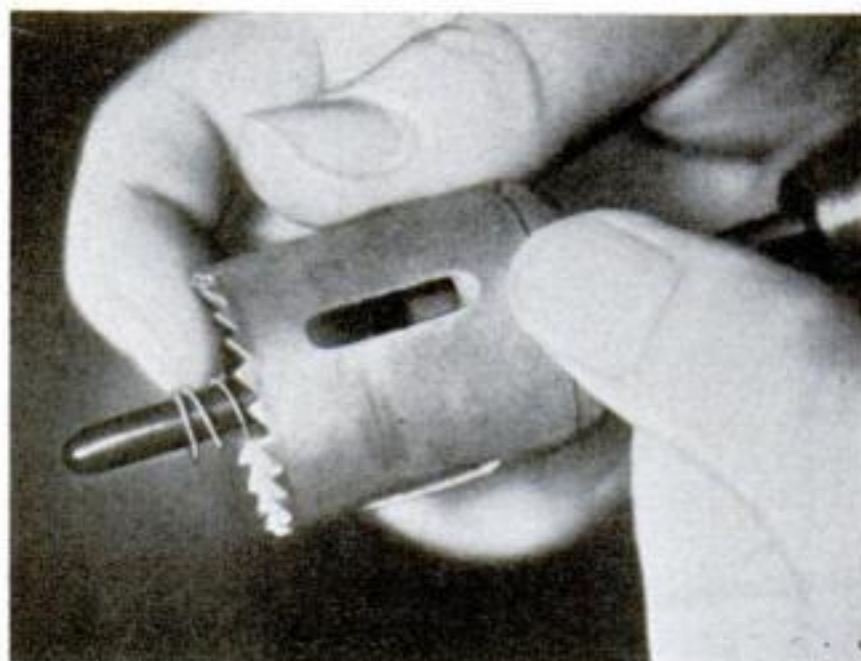
WORKING GEAR RATIOS can be shown on a lathe having change gears if a small indicator cut from thin brass, copper, or tin-can stock is mounted on the threading plate, as at right. If the metal is too brittle to bend fairly flat so a back section can be inserted between the plate and the lathe, two short pieces may be riveted together. Paint the indicator a light color. Adjust it to the proper setting with each change of gears.—W. E. B.

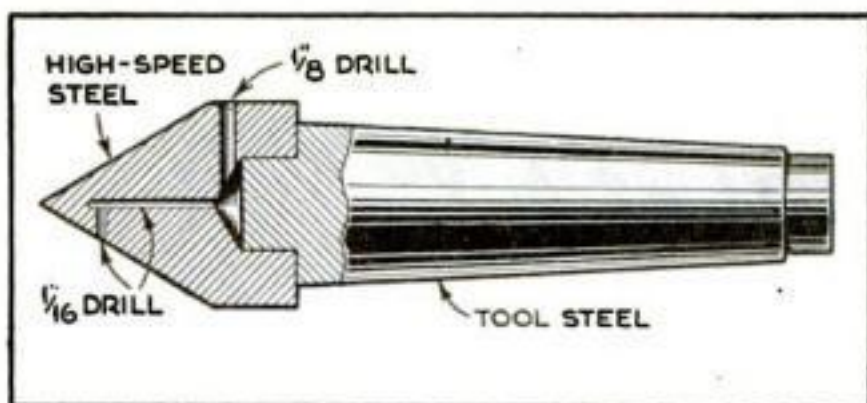


DUPLICATION OF A TAPER SETTING in the lathe can be expedited by passing a taper pin through the compound rest and into the cross slide. First set the rest accurately for the taper you will wish to duplicate, and drill a hole through a convenient part of the compound-rest base into the cross slide. Ream the hole in the compound rest with a taper-pin reamer, continuing into the one in the cross slide to a shallow depth only; then thread the rest of the hole in the cross slide.

Machine a taper pin to fit the holes, threading the small end and slotting the large end, and harden and draw the pin to a bronze or blue color. At another point on the lathe where it will not be in the way, drill and tap a hole into which the pin can be screwed for safekeeping when it is not in use. After that, it will be a simple matter to set the compound rest accurately in a few seconds.—W. E. B.

DISKS CUT WITH A HOLE SAW used in a drill press have a tendency to cling to the pilot and teeth of the saw, making it necessary to stop the drill press after each complete sawing operation in order to remove the disk so the next hole can be cut. This annoying delay can be eliminated by placing a stout coil spring around the saw pilot, as shown in the photograph at right. The spring is strong enough to eject the disk automatically as soon as the hole saw is lifted from the work, thus saving considerable time between operations, especially if a number of holes of the same size are to be sawed.—DE F. WHITE.





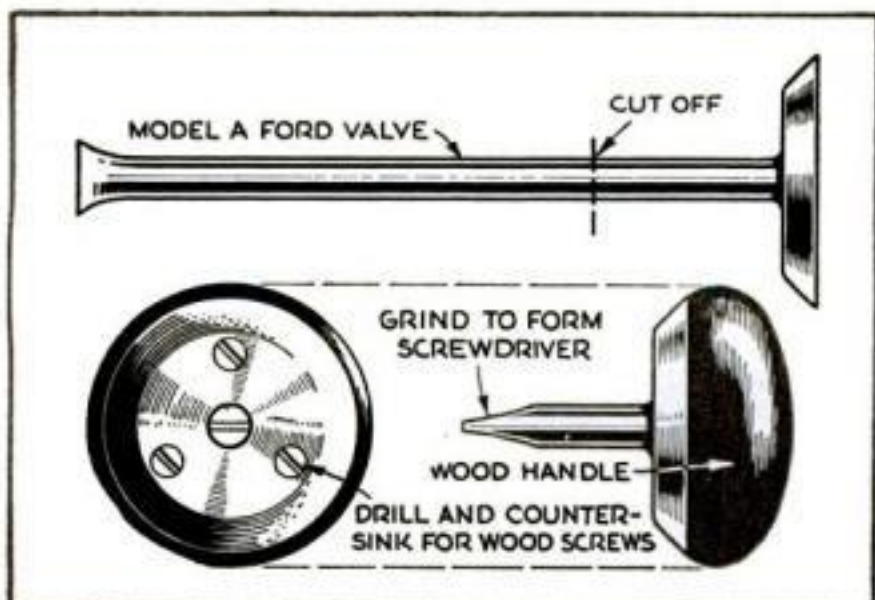
THIS SELF-LUBRICATING CENTER saves time by making it unnecessary to stop the lathe for oiling the tailstock center and is especially useful on a job where long cuts must be made to close limits.

Make the center in two pieces. Chuck the high-speed steel stock for the point, turn it to the required diameter, and drill out the recess for the shank. Drill the longitudinal oil hole while the piece is still chucked; then drill the radial holes on the crotch center in the lathe.

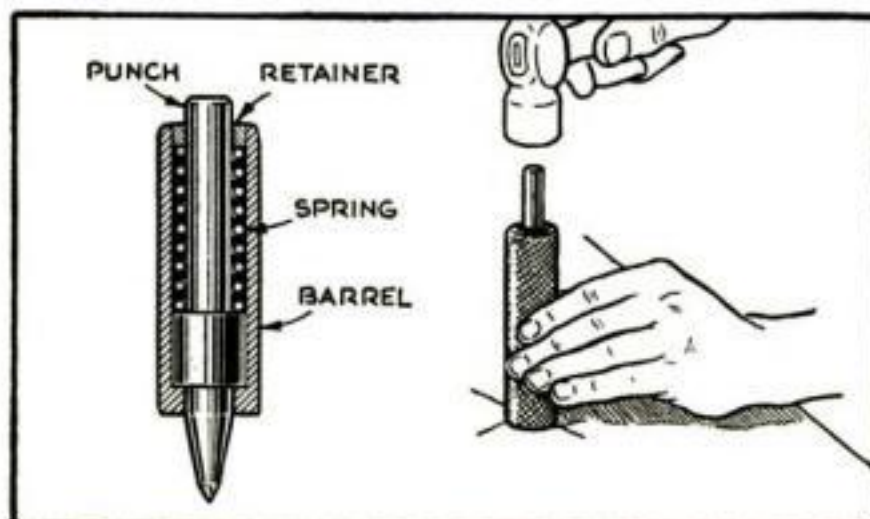
An old shank may be turned down for a drive fit in the point, or a new shank may be made. Assemble the two pieces, hold them in the headstock spindle, and turn the point to a 60-deg. angle. Be sure to leave on a little extra stock for later accurate grinding after the point has been hardened by heating to a lemon color and cooling with a blast of air.—C. W. BATTELS.

LAYOUTS ARE EASILY VISIBLE on metal surfaces coated with a solution of 2 oz. sulphuric acid and 2 oz. copper sulphate in 1/2 pint distilled water. Be sure to put the acid in the water, not the reverse. The solution will not rub off when dry and will show markings plainly.—HERBERT LONG.

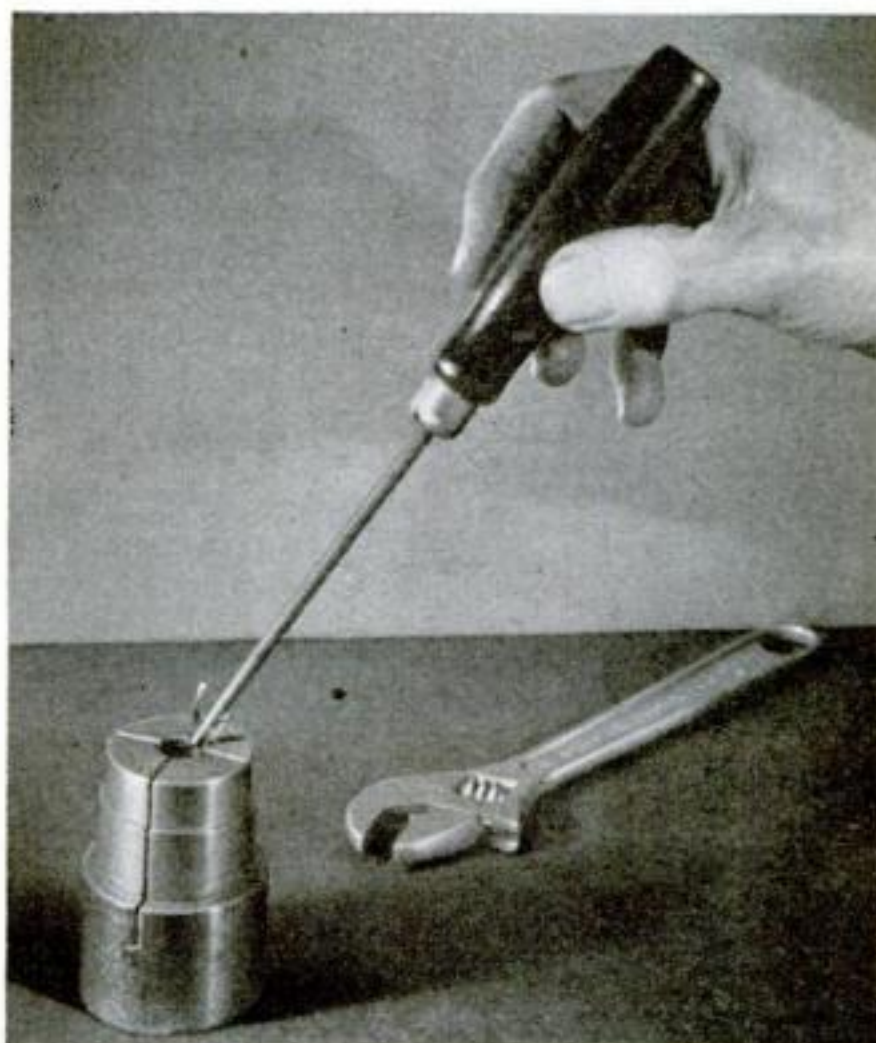
CLOSE-QUARTERS SCREWDRIVERS may be made easily from the head and part of the stem of discarded auto valves. Cut off the stem of a valve at the desired length and grind the end of the part left on the head to form the screwdriver blade; then drill the head for three wood screws with which a handle can be attached. The metal makes a tough tool.—W. H. BERGEMANN.



ACCURATE PUNCH MARKS for drilling centers can be made on flat stock with the centerpunch shown in the drawing below, since it can be held precisely at right angles to the work simply by pressing down on it so the bottom face of the sliding barrel lies squarely on the work surface. A spring in the barrel exerts sufficient pressure to keep the punch from slipping off the mark when the barrel is being pressed down. Turn the punch and barrel and knurl the outside of the latter to provide a good grip. Turn the retaining ring for a press fit in the barrel, harden and grind the punch, and assemble the parts.—H. D. CHAPMAN.



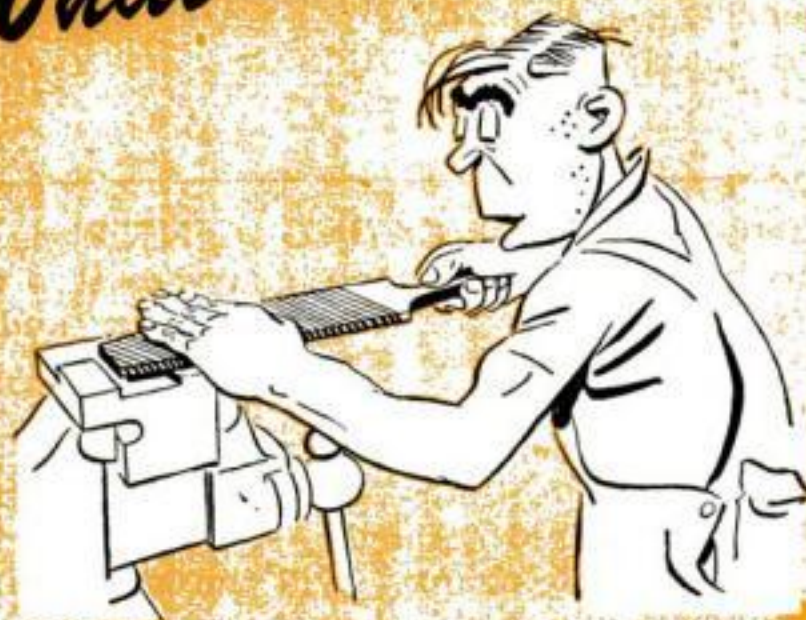
FITTED WITH A HANDLE and magnetized, a worn-out rattail file (below) will serve many shop purposes, such as extracting chips from holes and retrieving dropped nuts. Magnetize the file by drawing it across one pole of a strong magnet or by wrapping it with 50 or so turns of wire and touching the wire ends to the terminals of a 6-volt battery or a 110-volt circuit in series with an electric iron.—W. E. B.



What's Wrong?



1 Gremlin Gooch wants to take off a pulley that seems frozen to a motor shaft, so he brings his trusty screwdriver into play, not knowing that (a) he can't get a grip with it; (b) it's meant only to stand torsion; (c) the handle isn't right for prying. Which is it?



4 Filing is so easy Gooch never gives it a second thought—or a first one. If he did, he might realize (a) there's no handle on the file; (b) the file hasn't the right cut; (c) he's filing in the wrong direction



2 Gooch is a determined man with a wrench. Here he is (a) pulling it the wrong way; (b) holding the wrench wrong; (c) in need of a monkey wrench; (d) straining himself when he should be using a hammer



5 When he wants to drive a tight shaft out of a gear hub, Gooch applies the hammer with more vim than good sense. Oh no, he's removed the nut! Gooch won't bite on that. But (a) he's using the wrong hammer; (b) the shaft key is out; (c) he's holding the hammer wrong; (d) he needs something else

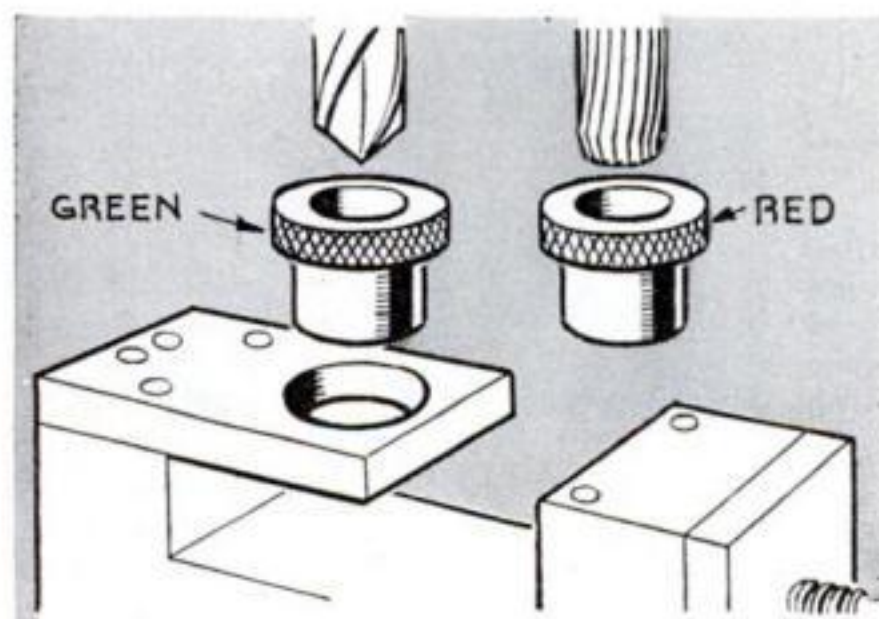
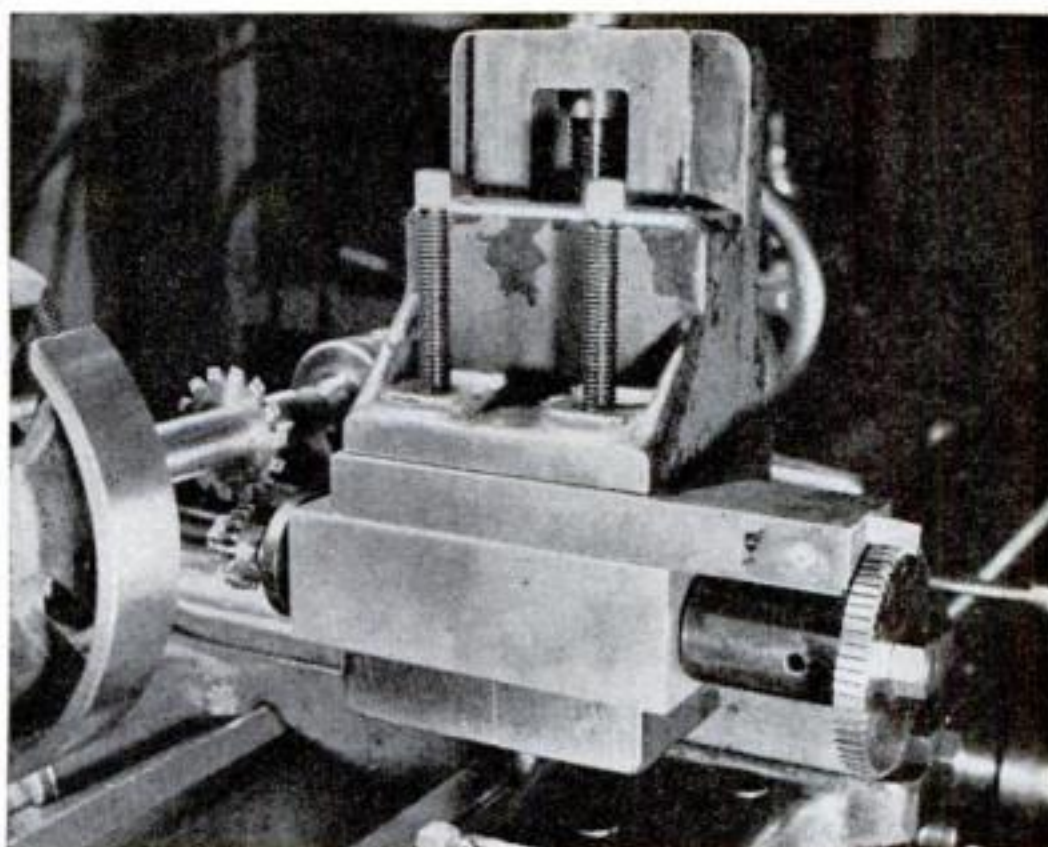


3 With a rivet to remove, Gooch means to show he knows what chisels are for. But (a) he needs a hacksaw; (b) his hammer's too small; (c) he's using the right tool at the wrong time; (d) it's wrong to use a chisel

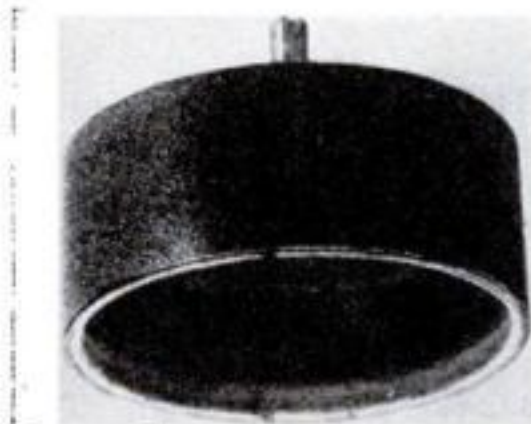
1—b. Screwdrivers stand twist; pry-ing may break a blade or bend a shank. 2—b. Turn the wrench around to exert force on the stationary jaw. Use open-end wrenches on standard nuts. 3—b, c. The hammer should be heavy enough to drive the chisel, and the nut should be slotted first with a cape chisel. Burrs on the head are dangerous since they may fly off. 4—a. Tangs are sharp and may cut your hand if you hit an obstruction. 5—c, d. Hold a hammer near the end with one hand and hit squarely. A brass or lead piece on the end of the shaft will prevent burring the threads. Where more than one answer is given, score yourself right for one.

ANSWERS

MILLING IN THE LATHE is accomplished readily with the setup shown at the right, an attachment measuring 3" by 3" by 6" and having a 1½" radius index. With it, W. G. (Fred) Mendenhall, a graveyard-shift employee at the Lockheed plane plant at Burbank, Calif., is able to mill gears, splines, squares, and bevels, using either a fly or a milling cutter. The attachment, shown on a standard South Bend lathe, is accurate to .0001" and is fast and efficient. The machine is easily portable, and it is especially adaptable for use with traveling machine shops which otherwise might have no accurate milling machinery. —H. D. BALLENGER.

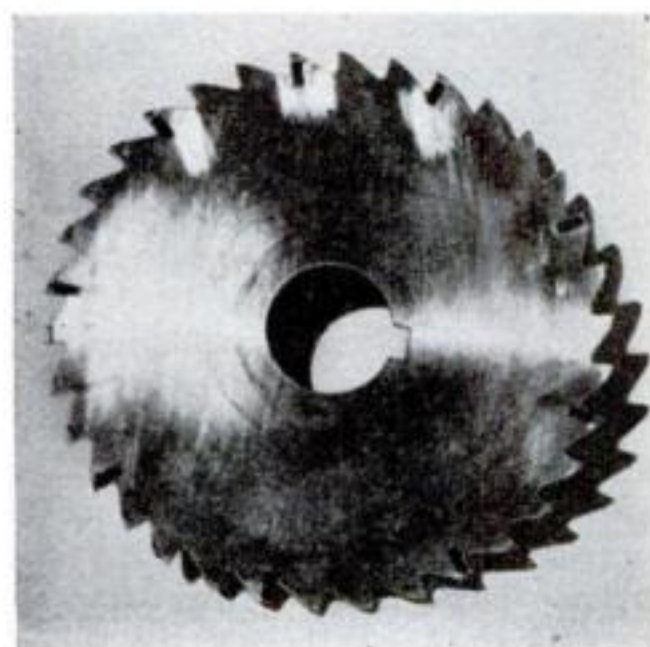


IDENTIFYING COLORS on the shoulders of slip bushings used in drilling with a jig will often speed operations. This is particularly true where a job calls for a hole that is first to be drilled with an undersize drill bushing and then reamed with a full-size ream bushing. To increase speed in war-plant operations, the shoulders of the drill bushings are painted green and those of the ream bushings red, providing a quick means of distinguishing them and making it unnecessary for a workman to have to read the size numbers stamped on the bushings each time they are used.



POLISHING OF TUNGSTEN CARBIDE with diamond dust is now done at the Pratt & Whitney plant at West Hartford, Conn., by means of a felt-lined inside-polishing wheel made of sheet metal in the form of a cylinder having one closed end and a shaft that is inserted in the collet of a speed lathe or the chuck of a bench motor. Centrifugal force tends to throw dislodged diamond dust back into the felt, thus preventing loss at high speeds. The ingenious wheel does in a few minutes a fine polishing job that formerly required hours when it had to be done by hand.

TIPPING HIGH-SPEED STEEL SAWS with Carboloy cemented carbide has been found at the Springfield Armory to be an efficient method of lengthening the life of tools employed in milling parts of the Garand rifle and even to be a means of salvaging worn tools. Nine teeth of a 34-tooth middle saw in a gang of three were first tipped with the material after some 950 aperture slots in base rear sights had been milled. The first run of the tipped saw finish-milled 2,600 pieces, and it was found that one or two teeth were slightly high and had to be ground. On a second run 3,199 pieces were milled before grinding became necessary. The armory now tips every other tooth of all three saws in the set, not only reducing machining time, but also improving cutting characteristics.

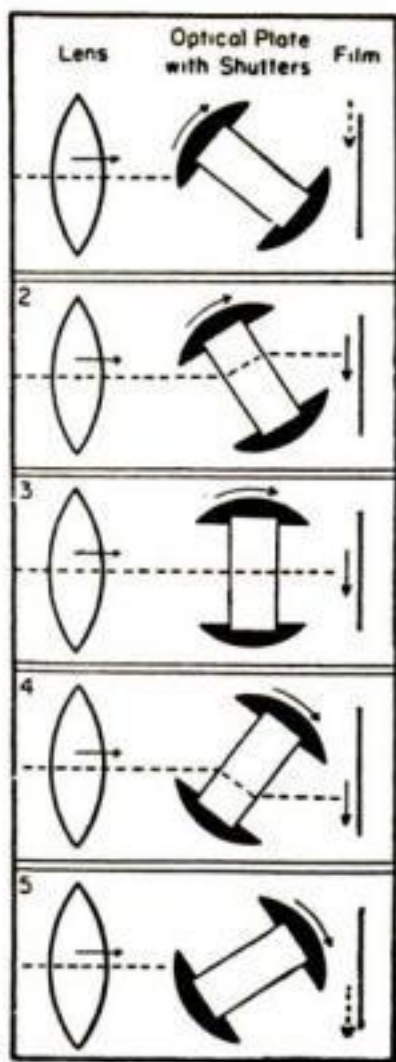


SUPERSLOW MOVIES, expanding the possibilities of analyzing the moving parts of machinery, are taken by a new type of camera that employs continuously moving film. While ordinary cameras using intermittent film movement are capable of speeds of 32 or 64 frames per second, this machine will make 500 to 3,000 exposures.

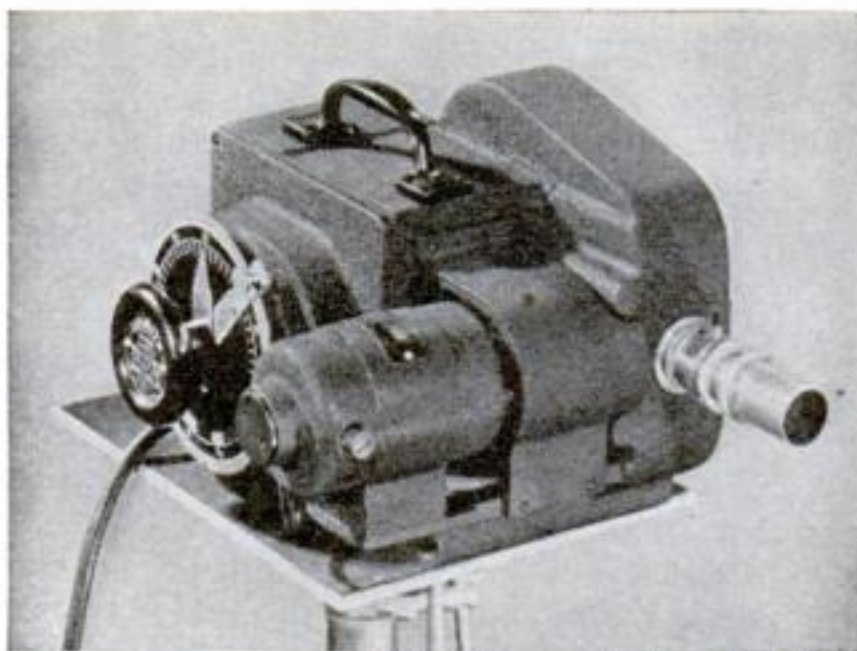
An optical mechanical device interrupts the image-forming light ray at rapid intervals. This permits continuous flow of the film at an extremely high speed and provides the basic principle of the new camera.

Rotating rapidly between the lens and the film, as shown in the drawings, an optical plate with opaque end pieces, which act as shutters, alters the path of the light according to its position. This shifts the image uniformly downward until the light is cut off by a shutter, the image staying in the same position on the film during any single exposure interval.

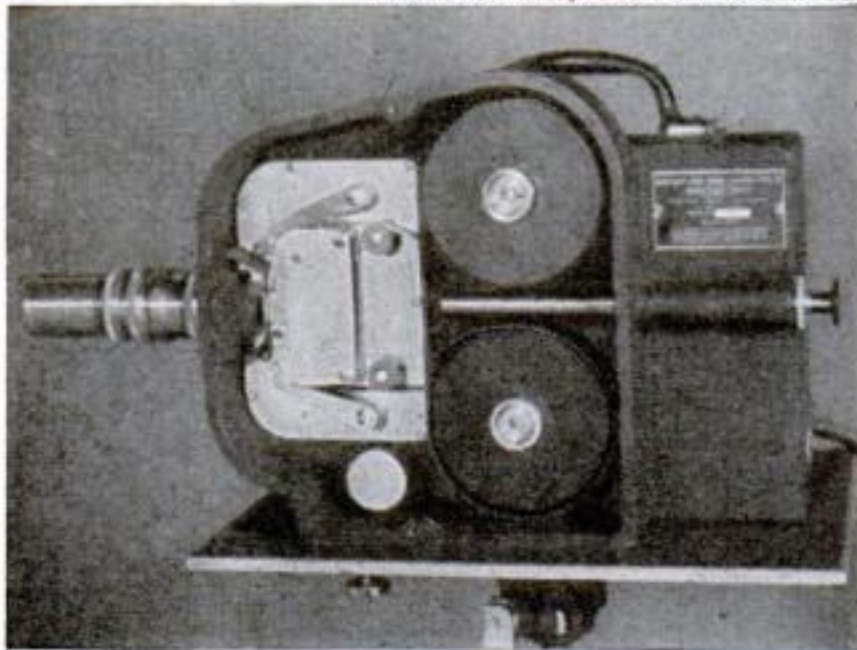
In using the camera, 50' or 100' rolls of film must be allowed to run through at one time, a switch being set to cut off the motor



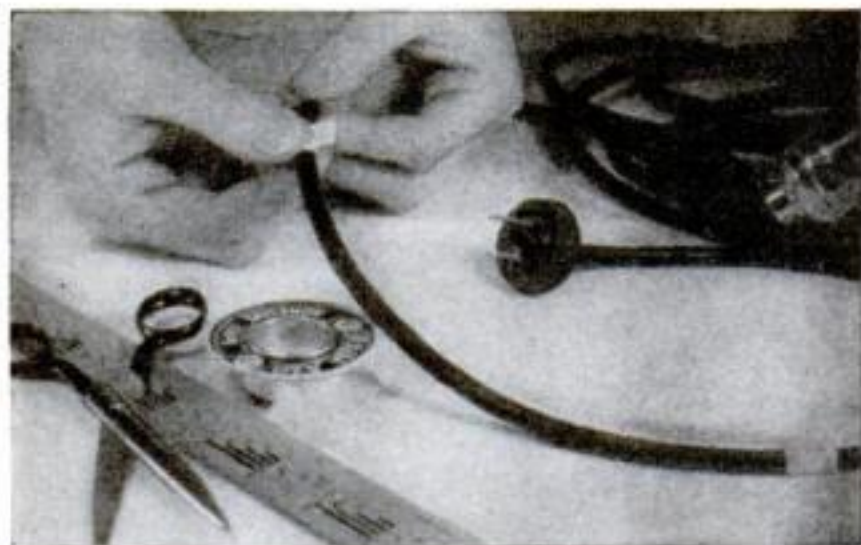
Synchronized rotation of the optical plate deflects light rays so that the image moves along with the strip



Photos Courtesy Eastman Kodak Co.



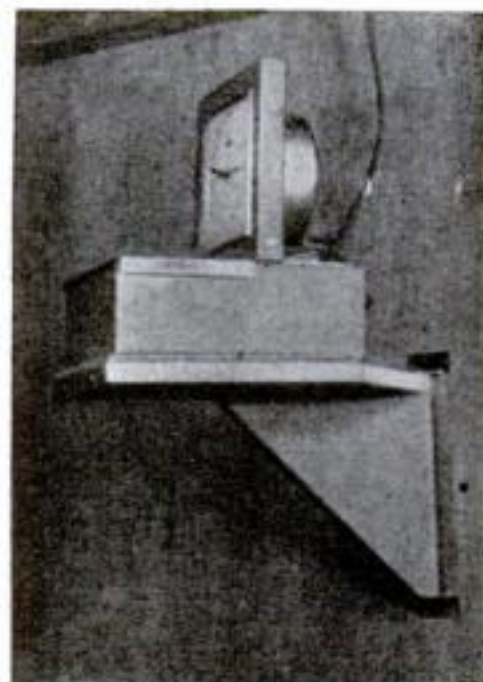
at the end of a take. Speed is adjusted by a rheostat. At a setting of 3,000 frames per second, the maximum speed is reached gradually. A rate of 2,400 frames is attained in the first 20' of film.



INDOOR PHOTOGRAPHY calls for frequent measuring off of distances from lens and lamp to the subject. A convenient and accurate means of measuring is afforded by calibrating the light cords of the reflectors. One easy way to calibrate the cords is to mark off intervals of 6" or 12" by pieces of adhesive tape bound around them. Such markings can be located by touch in dim light. Tape contrasting in color with the cord is best.—WILLIAM SWALLOW.

SAFE ILLUMINATION for a darkroom clock is provided by the simple light-reflecting box shown in the photo below. An ordinary electric clock with a sweep second hand is mounted on a light-tight wooden or metal box containing a socket with a small light bulb. That part of the box cover in front of the clock is formed from a safe-light filter sliding on two pieces of brass angle; the remainder is the same solid material of which the box is made, and under this the socket is installed. The front part of the box interior is painted white.

The clock may be set on a vertically hinged shelf as in the photo, and thus swung to any angle to eliminate parallax.—B. B.





This "Girl with Grapes" has both composition and human interest for a home recording of a harvest

Editing Home Movies Before You Shoot

By PHIL TANNURA, A.S.C.

Being an actor, director, producer, and cameraman filled the author's 35 years in films. He was official cameraman for Henry Ford's 1915 Peace Ship and the 1918 Siberian A.E.F. What he likes best is photographing such pictures as "Counter-Espionage" and "Laugh Your Blues Away," which he did for Columbia.

MY DIRECTOR and I stand alongside the camera surveying a set whose thin walls and carefully placed furniture are lighted partly by sun arcs shining from a make-believe garden through glassless windows.

"This," he explains carefully, "calls for three shots—long, medium, and extreme close-up.

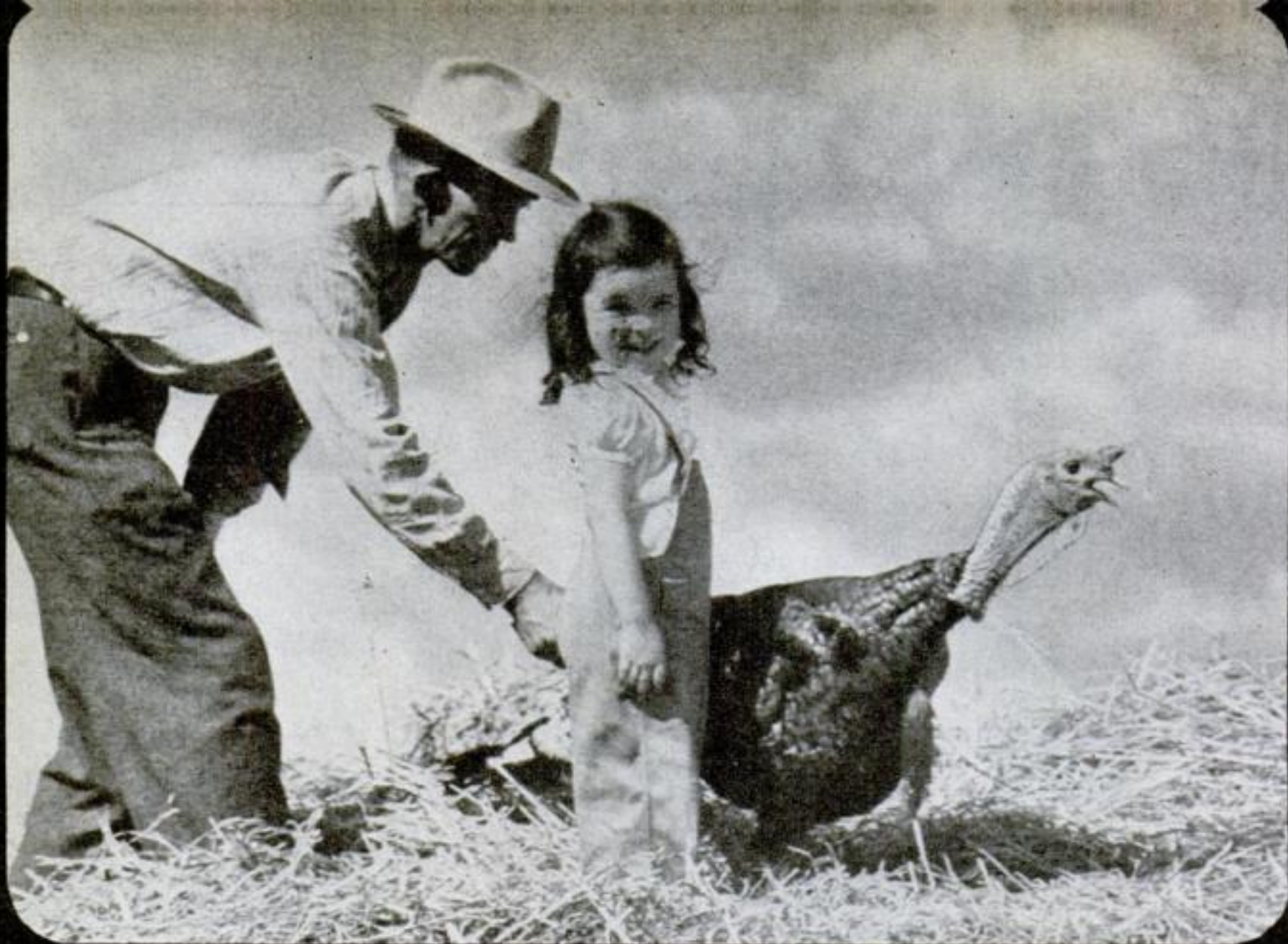
"Not this time," I disagree quietly. "We have to hold it to a pair."

"Why?"

"Because, Chief, our film supply is cut one fourth. The studio holds me to three takes on any one scene, too."

It's now an old, though very necessary story. Not enough film to go around—35 mm., 16 mm., or 8 mm. Just as you amateurs do, we professionals must make every foot count, with this single difference: our reputation depends upon whether you like the product that finally reaches the screen.

Entertainment values need not suffer because film and other supplies have been curtailed. While it may be impossible for you to make very long pictures, family records, shots of the baby at play, and a record of Jim's visit on furlough will provide short bits of lasting interest. Forethought and careful planning will enable you to eliminate



The turkey can be held for sister to make friends. A close-up will put the grown-up outside the field

unnecessary sequences and to crowd into single scenes action that formerly required several.

How may this be accomplished? Simply make every scene complete within itself, blending camera angle, composition, action, and subject matter into a record the entire family will enjoy. It may seem at first like trying to pour two quarts of milk into a one-quart bottle. But with patience, you will find you can crowd your artistry into more compact packages.

Follow the slogan: "Before investing, investigate." Before shooting, plan your course of action. Almost without exception, you will wish to include at least one person, both to lend interest to a more general setting and to add to valuable documents accumulating in your library. Consider these suggestions:

1. Try for close-ups to catch individual personality and fleeting expressions that become cherished memories.

2. Let your camera record, not provide, action by holding it steady in your hands or on a tripod.

3. Seek eye-arresting and pleasing composition at all times.

4. When logical, employ foreground framing to secure better balance.

5. Set off your subject to better advantage

by trying for good side and back lighting.

6. Experiment with various camera angles to obtain better, more dramatic effects.

7. Keep records of memorable family gatherings based upon "planned action."

8. Limit footage and eliminate waste by editing before you shoot.

To make your picture tell a story at as little cost as possible, keep the idea simple. Try for unposed action, but, except for an occasional "gag" shot, do not let your subjects stare into the camera. And don't be afraid of close-ups! People are the most interesting things on earth, both to themselves and to each other.

You are familiar with the meaning of close-up, semiclose-up, medium shot, and long shot. With a standard lens, a close-up at 6' would show head and shoulders; at 10' the camera would cover from head to waist; head to feet, at 15', is a medium shot; and your subject will be part of a general scene at, say, 50' to 100'.

In the past, to obtain a complete story, you have combined scenes taken at two or more distances. It's a simple matter to pack them all into a single sequence. Here's a good example:

Something new has been added this year to most of our homes. Maybe it's a flock of chickens or turkeys. You want a record, but

certainly not a single, long shot of the birds in their yard, so combine a long shot and close-up in a single scene. Suppose you open on two members of the family catching the Thanksgiving turkey and then walking forward with their prize. At a previously marked point 6' or 8' from the lens, have them halt for a smiling discussion of its succulent merits. After a moment, they turn and walk toward the side, out of the scene. Without moving or halting the camera, you can thus combine all the elements necessary for a complete story. Remember, though, to change focus as your subjects move toward the camera.

Your first inclination will be to shoot everything from eye level because that's how you look at objects. It does not necessarily follow, however, that every picture should be at that level. If you have occasionally shot upward to catch the towering effect of a monument or tall building, you will realize how much more effective such a picture can be. Camera angling helps develop wanted qualities in many objects and people. Shoot up to emphasize Dad's tall and sturdy physique, down to bring out Baby's diminutive stature.

Many shots that seem difficult are really easy to make when you know how. Sister pokes painstakingly at the typewriter. Cute, yes; but how much more interesting if the cat interferes. That's easy, too. Place your camera so it looks slightly down (remember your angles), embracing nearly all the table in its field. Sister begins to type, and the cat, attracted by the motion and sound, walks into the scene from the outer corner. Sister scolds pussy, takes him into her lap, and resumes typing. Fade.

Junior sits eating in his high chair, and the dog climbs up to grab a share. Place the camera so it looks slightly up, and whistle for the pup, grown menacing because

his apparent size has increased with the angle, to jump onto a chair, placed conveniently near. He will keep going, looking for bits of meat or biscuit "planted" around the cereal bowl. Let nature take its course, closing on the baby scolding or laughing.

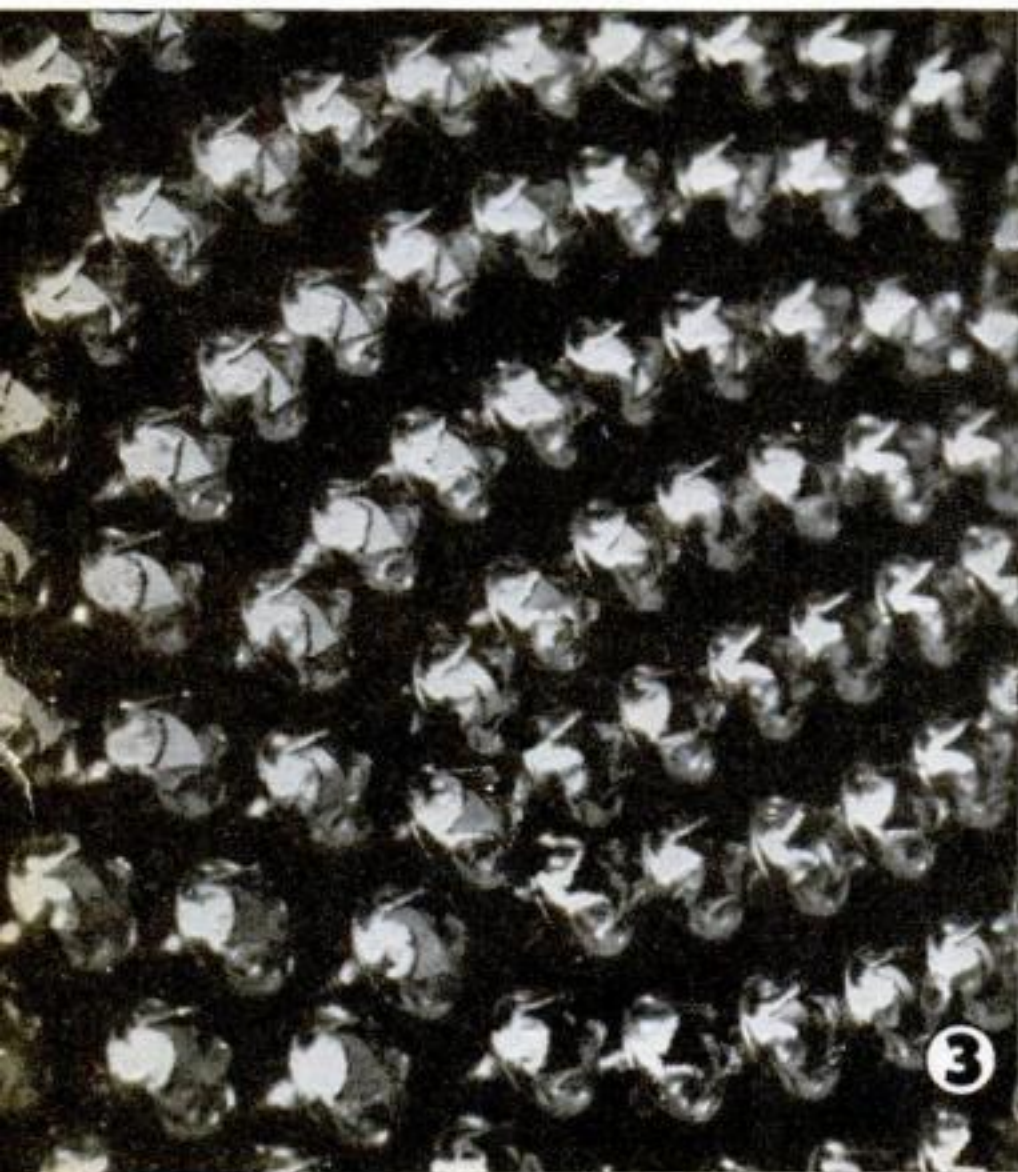
When visitors arrive, try for a little novelty by shooting down from a ladder as they walk toward the front door, waving and smiling as they pass. Such pictures accentuate the face and shoulders, and give an unusual touch to your scene.

In both close-ups and long shots, interest in your subjects will be heightened by making sure of pleasing composition. A good rule is: If you like it, shoot it; if not, rearrange your people or move to another location and study the scene in your finder.



A single short scene may record sister's efforts to typewrite—with the help of the kitten. Note the angle of the shot. Below, the camera is at eye level to show mother feeding the baby as you see them naturally





WHAT ARE

Name These Enlarged Pictures

JUST to prove that things aren't always what they seem, and that often the closer you look at some things the harder it is to see them, we give you a series of superclose-ups on these pages. What do you think they are? Is that a stack of cordwood or a pile of railroad ties in No. 1? And how about No. 2? Would you call it a new kind of barbed wire being made for the Army?

The answers are printed at the bottom of this column, but before you turn the page over to read them, try to name the pictures yourself. They are all familiar objects, but each is greatly enlarged. That's the nub of the trick.

Try making superclose-ups yourself. You'll see that when you enlarge a subject to many times its normal size, and then crop the photo so there is nothing in proportion to be recognized, all resemblance to the original can be hidden.

To make your fun still more interesting, POPULAR SCIENCE MONTHLY is offering eight cash prizes totaling \$50 for the best photo puzzlers of familiar objects received from readers by midnight, August 15, 1944. The awards will be made as follows:

First Prize	\$25
Second Prize	\$15
Third Prize	\$ 5
Five Prizes	\$1 each

All you need to do is to submit an enlarged photo puzzler of a familiar object

1. Rubber bands. 2. Cactus spines. 3. Food-grater teeth. 4. Spaghetti. 5. Pineapple skin. 6. Edges of Graham crackers.

ANSWERS

POPULAR SCIENCE



THESE PHOTO PUZZLERS?

of Everyday Objects—Then Make Some Yourself for Our Prize Contest

cropped something like those shown on these pages and submit also a photo showing the same subject in a way that it can be recognized. These two photos may be made either from the same negative or from different ones. However, on all photos in which the subject can be identified, that portion that has been enlarged to make the photo puzzler should be marked for comparison by the judges. Write your name on the back of both photos.

There are several methods of making superclose-ups. One way is with a camera having a double or triple bellows extension similar to that shown in the photo at right. By extending the bellows so the distance from lens to film is twice the focal length of the lens, you can make life-size photos of objects in sharp focus.

A supplementary "copying" lens, which is a positive (magnifying) element placed over the regular camera lens, shortens the focal length of the regular lens and makes it possible to obtain larger images.

You can also get bigger images by replacing the regular lens with one of shorter focus. A 2" miniature-camera lens, for instance, may be put in a camera that regularly has a 6" lens.

If none of these methods is convenient, you can simply enlarge a normal photo. You can also enlarge a superclose-up if you wish. But be sure the results are clear.

Use a very small lens aperture, such as $f/22$ or $f/32$, for sharp superclose-ups, and give a corresponding long exposure. In lighting the object, get contrast by using direct sunlight or a single spot at an angle. A supplemental No. 1 or No. 2 photoflood will often soften harsh shadows.

\$50 IN CASH AWARDS

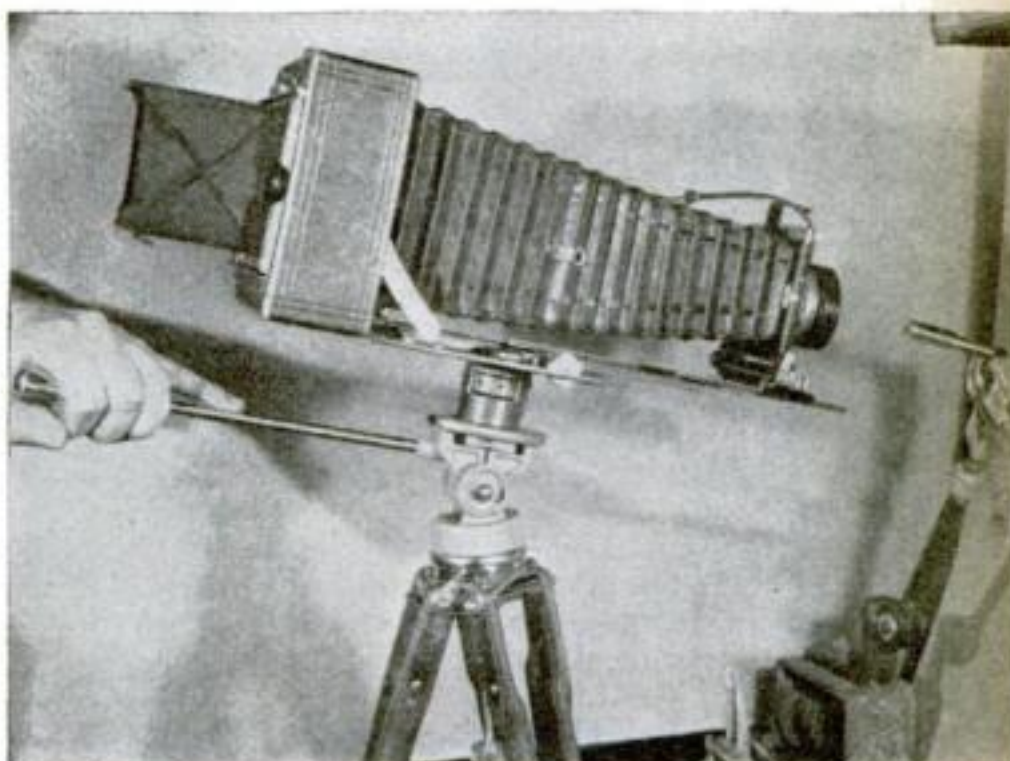
RULES

Mail entries to the Photo Puzzler Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York 10, N. Y., accompanying each puzzler with a normal identifying photo.

The judges will be the editors of POPULAR SCIENCE, and their decision will be final. Duplicate prizes will be awarded in case of ties.

No photo will be considered that arrives after August 15, 1944.

Professional photographers and employees of this magazine are barred.





Bofors antiaircraft guns form a striking design before the camera lens as they are lined up ready for delivery at Firestone's plant in Akron, Ohio

Patterns for Victory

NOT futuristic art, but holding a promise for America's and the world's future, the photographs on this page are of everyday scenes in the gigantic production-for-victory program in this Arsenal of Democracy.

Aircraft and antiaircraft guns and airplane-engine cowlings are a small fraction of the vast works in our new and converted war plants, but they occupy important places in the intricate pattern for victory. Multiplied by the millions, they indicate a bright future for the United Nations.



Muzzles and breeches of 20-mm. machine guns (above) alternate in closed ranks at a converted auto plant. The weapons await installation in fighting planes

At right are yawning craters of aluminum alloy—cowlings at the Douglas aircraft plant in Santa Monica, Calif., where they will become streamlined housings for powerful American plane motors





By ELON JESSUP

MEN experienced in salt-water boat yards will tell you that if you put off the repainting of a bottom for as long as two years your boat is a goner. With new pleasure boats now practically off the market, this means that your old craft, if it is to last and give good service, is going to need a repaint and varnish job without delay.

But professional painters are hard to get nowadays, and the boat yards are all busy with Navy work. It looks as if you will have to do the job yourself.

Good paint, fortunately, is still procurable. Some are of the opinion that sooner

Paint IS LIFE INSURANCE FOR Your Boat

Timely work with the brush will prove the real key to keeping any craft, small or large, always in good trim

or later it won't be. It contains ingredients—especially copper bottom paint—needed for the war. The wiser boat owners aren't taking a chance. They say, get the paint and put your boat in first-class condition while you can.

Your craft may be anything from a 7' dinghy to a 60' cruiser. The method of painting it won't vary basically. But in every case you must investigate and formulate a definite plan. Otherwise you may either skimp on essentials or let yourself in for a lot of hard work that isn't necessary. A boat-painting job can be made easy and still be thorough, or it can be difficult and complicated. Take it easy. And take your time. The job simply can't be rushed.

A good example of planning is in deciding the question of whether or not an old paint surface ought to be completely stripped off—down to the bare wood. In some cases this will be essential, while in others it won't. Again, on a given craft, stripping may be required for the topsides and not for the deck—or the opposite may be the case. You must investigate and judge for yourself. It would be foolish to disturb old paint that is solidly bonded to the wood and neither cracked nor blistered. A solid, firm base of this sort is an excellent one upon which to spread a new coat of paint.

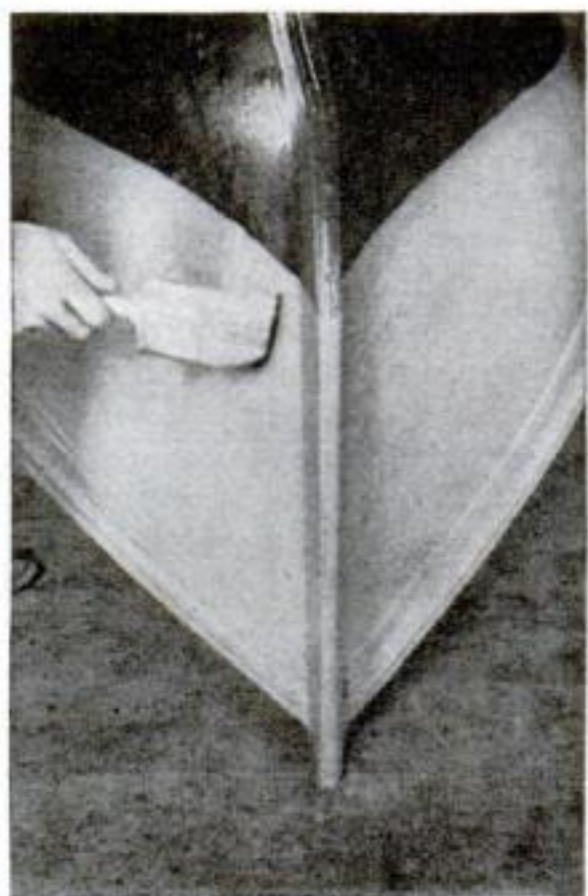
Complete stripping down is required when the old paint has gone lifeless and no longer provides a firm base to which new paint can cling. But it is usually a matter of years before this stage is reached. To strip down a boat every year, as some boatmen do, is rarely necessary. You will recog-



For a good job of stripping, use a blowtorch to soften the old paint so it can be removed with a putty knife



Thorough washing with fresh water and a stiff broom will show up defects that need repair. Sand the surface of your boat, as shown below, before applying paint; then start painting at the bow and work all the way around



nize the real need by the cracking, blistering, and flaking of the old paint. And you can be sure things are in bad shape when the paint peels off in strips. The best way to find out how matters really stand is to go over the entire surface with sandpaper.

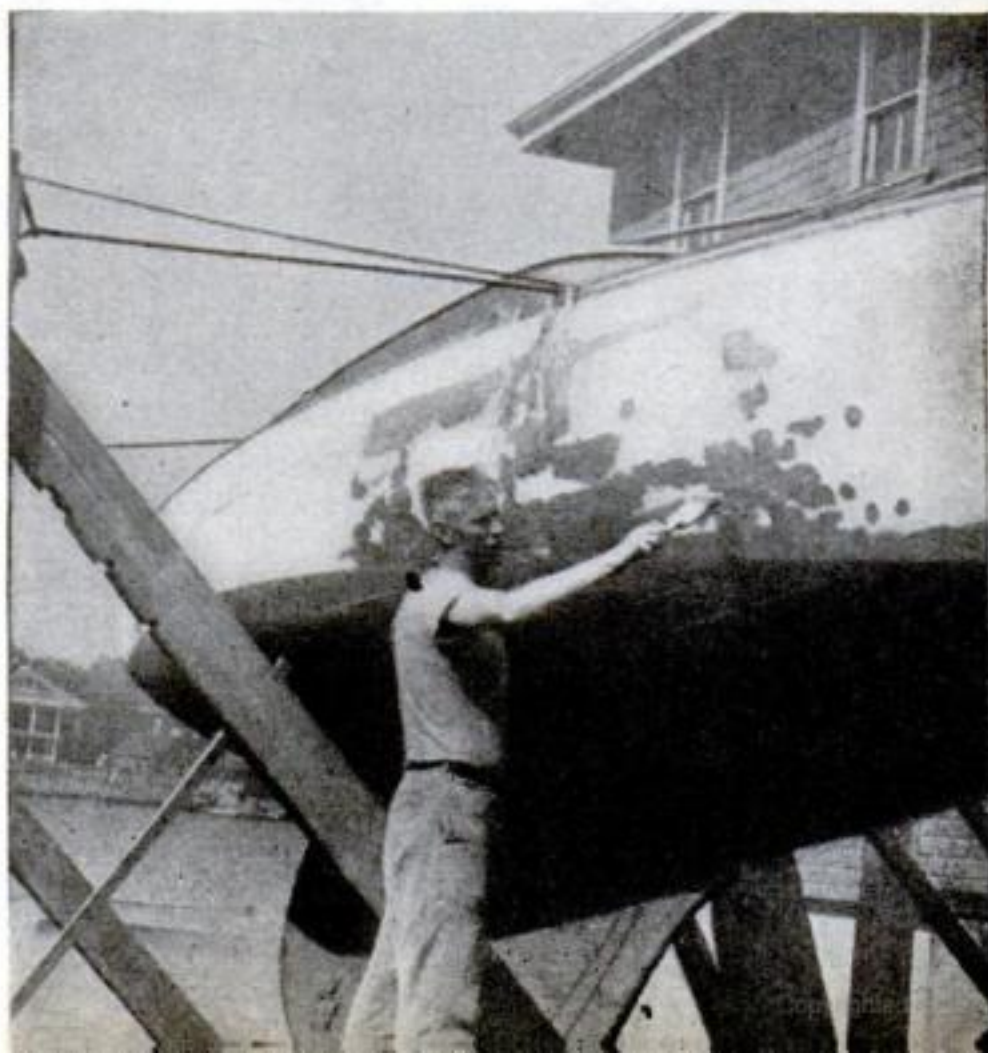
There is a convenient short cut for dealing with flaked and blistered paint. This is a method known as spot painting. After a thorough sanding of the surface to bring off all the old paint that can be loosened, leave the paint that remains firm undisturbed and then paint only the spots where bare wood shows. The boat will look like a leopard at first, but after the spots have dried, a finishing coat is spread over the whole surface, and then your craft ought to look as good as new.

A more thorough and lasting method of treating flaked and blistered paint is to strip down the entire old paint surface. A blowtorch is the favorite tool for the job, and it provides the easiest way. The torch is held in the left hand while, with a putty knife in the right, you peel off streaks of hot, softened paint.

Be sure never to use a blowtorch on canvas—either canvas decks or sides. It is likely to scorch and ruin the cloth. Paint remover should be your medium for stripping this material. The use of paint remover is also more suitable than a blowtorch for varnished surfaces. Black scorchings from the torch will always show unpleasantly through a new coat of varnish.

Another tool that does a good job of stripping both paint and varnish is a power sander. Its use, however, is

Paint flaked and blistered in patches may need to be removed only on those spots. Then . . .



sometimes more practicable for decks than sides, for a power sander is a heavy implement to hold against a sloping topside.

It is difficult to plan the real painting requirements of a boat without first giving the craft a sound scrubbing with soap and water, inside and out, from stem to stern. This may disclose certain structural weaknesses as well, such as loose fastenings or spots of dry rot in the wood. Now is the time to repair these places, before any new paint goes on. There is one exception to this. You will probably find seams and nail or screw holes that need to be puttied. Postpone this particular chore until after a priming coat has been applied over the wood. When this has been done, the putty will cling all the better.

Both the weather and the amount of protection your boat enjoys will have a bearing upon how you plan the actual painting. If the boat is berthed in the open and has a cabin, it may prove good planning in uncertain weather, such as that occurring in the early spring, to tackle the interior first. But generally speaking, it is a waste of time to paint or varnish during damp or cold weather. Even if you have your boat under a shed, wait for a spell of settled, fair weather. Then do the painting from about 10 o'clock in the morning until three in the afternoon to obtain the best results.

It will make your work easier in the end if you give the boat a second thorough scrubbing with soap and water a short time before laying on paint. After this, regardless of whether a complete stripping down has been done, it is essential to sandpaper all parts that are to be painted. If this sandpapering brings off any blister patches, spot-paint them and let the paint dry. The surface should always be thoroughly dry and

free from dust before any paint is applied. If paint remover has been used, the wood should be washed down with turpentine to get rid of the wax in the remover.

Generally, the easiest system in painting is to start at the top and work down—as you'd do in painting a house. However, some boatmen find it more convenient to paint the topsides before the deck, that is, the sides between the water line and rail. The bottom comes last. Use only a reliable marine paint—not a house paint. No matter how good, house paint won't stand up in the water the way marine paint does.

Here is the easiest and best way to paint the topsides. Commence with the brush at the starboard bow and work aft, gradually going around the boat in a clockwise direction and ending up where you started under the bows. This is, of course, on the supposition that you are right-handed. In following this method, you profit by having a finishing stroke that is continually forward instead of backward. A person accustomed to holding the brush in his left hand will get the same results by starting at the port bow and working around the boat counterclockwise.

Two coats should be enough on an old, firm paint base. Thin down the paint with turpentine for the first coat, perhaps by about 10 percent. The second coat will usually be laid on as it comes from the can. Paints vary, however, and the best system is to follow closely the directions a manufacturer prints on the container.

After the first coat has been applied, putty seams, nicks, and holes where this is needed. Although in some instances recalking may be required, as a rule it is best to leave the old calking undisturbed. As for putty, ordinary window-pane putty won't

... for a first coat paint only the bare spots. A finish coat will complete the job

Names of boats and identification numbers are easily put on with a stencil after the final topsides coat has dried



do. The variety most used for general plugging is white-lead putty. For seams—including those on the deck—a putty of prepared elastic seam cement is preferred.

Painting of decks and the interior follows much the same procedure as that of the topsides. Here, too, be sure the first coat is thoroughly dry before laying on the second. If the weather isn't just right, the surface may remain sticky for days or even weeks. Don't rush it. Before applying the second coat, sandpaper the first lightly.

Between the topsides and bottom on some boats, but not all, is a wide, decorative stripe running from stem to stern. It is known as the boot-topping and serves as a sort of water-line barrier against grease and dirt in the water. Paint it with a very hard enamel that will take plenty of scrubbing.

Then, finally, you get to the bottom and something radically different in paints. There are many kinds of bottom paints. Your selection should be determined first of all by whether your boat is kept in fresh water or salt water. The safest rule to follow is to choose the brand commonly used by boatmen in your own locality.

The marine pests of salt water require special ingredients in a paint. Marine worms won't go through paint, but they will quickly penetrate any bare wood where paint has come off. Watch the boat's bottom. It is the part of a craft requiring the utmost attention and, unless properly protected, it is sure to give trouble. The bottom of every salt-water boat must be painted once a year at the very least, and usually it should be painted even more frequently.

Most pleasure craft that cruise salt water require a soft copper antifouling bottom paint. Before applying it, sandpaper the bottom to free it of all loose paint and dirt. Boat yards sometimes speed this job up by playing a hose on the bottom and scrubbing with a harsh broom. The surface must be left to dry, after which the first coat is applied. Between coats, as in the case of topsides, putty up all holes.

Let the first coat dry thoroughly before applying the second. But this second coat is treated differently. Postpone putting it on until about an hour before the boat is scheduled to go overboard. The bottom ought to go into the water still a little wet. When it does, there will be a slow release of poison from the paint to discourage parasites from taking hold.

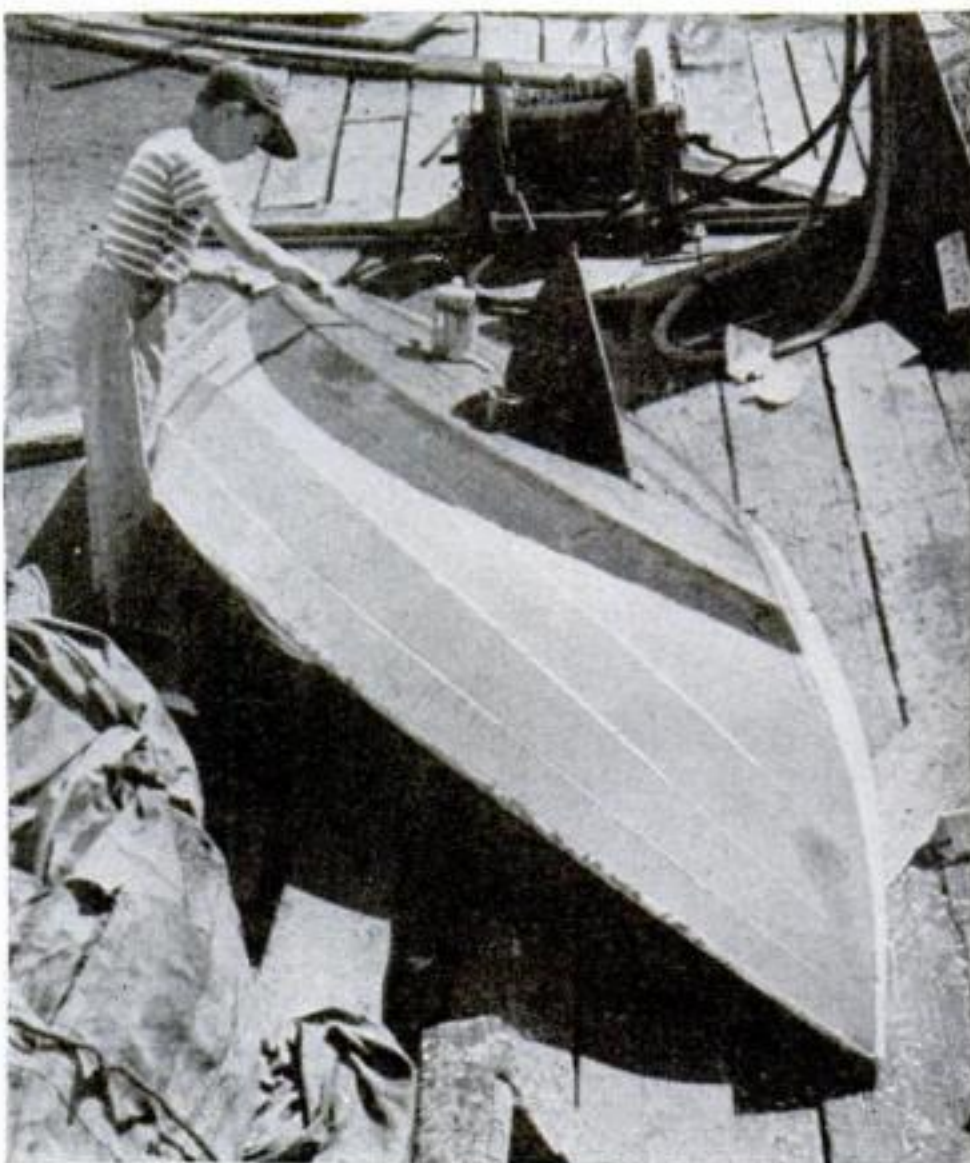
The fresh-water boat owner hasn't as much to worry about. A hard-surface paint and an occasional scrubbing ought to keep the bottom of his craft clean.

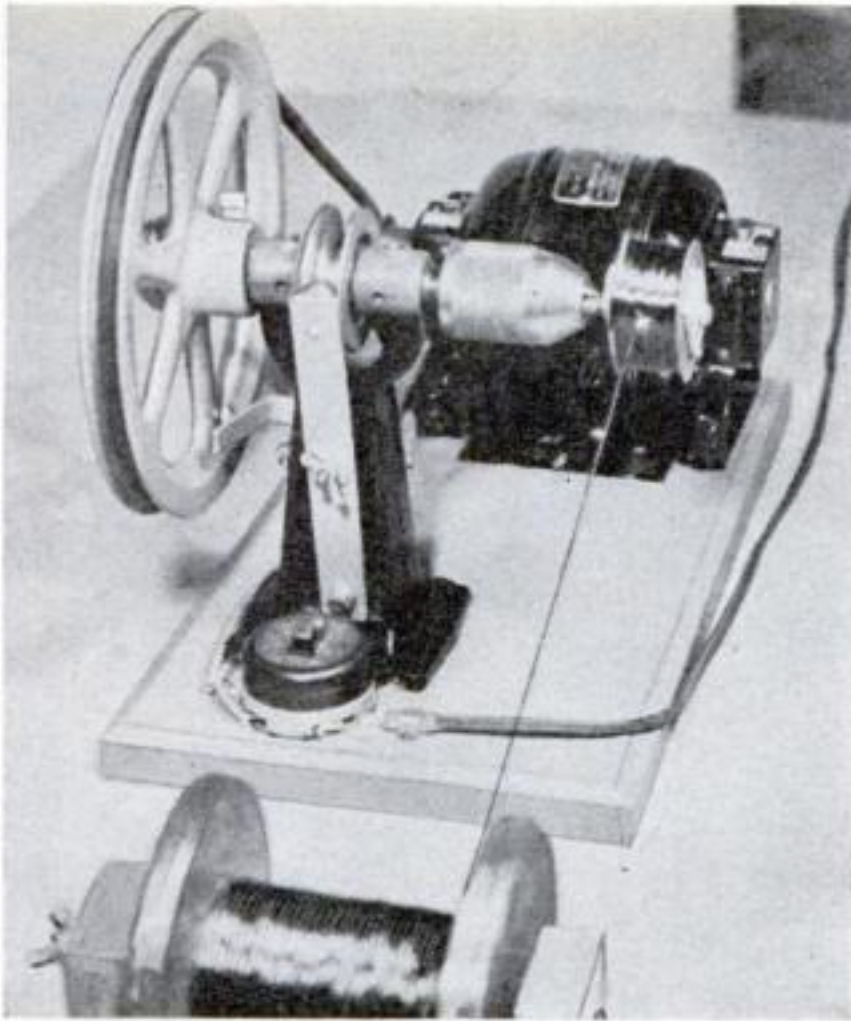
While any boat is afloat, give her a periodical washing with fresh water. This keeps salt and dirt from baking into the paint.



Hard enamel on the boot-topping at the water line stands scrubbing to clean off grease that collects

Seams, nicks, and nail and screw holes should be sealed after the first coat for best results. An elastic cement and a white-lead putty are needed





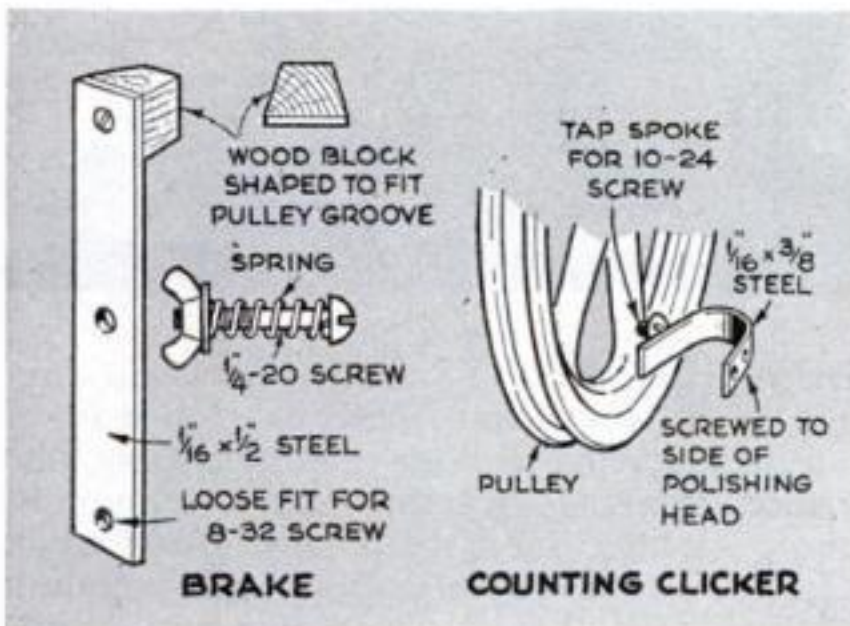
Polishing Stand Is Rigged Up for Accurate Coil Winding

COIL winding for radio and other electrical equipment can be accomplished quickly and accurately with the device shown at the left. This winder was made from a low-speed (1,150-r.p.m.) motor and a polishing stand having a $\frac{1}{2}$ " shaft with a left-hand thread on one end and a right-hand thread on the other. A 7" diameter pulley taken from an old refrigeration compressor was attached on the left-hand thread and, since the diameter of the motor pulley was $1\frac{1}{2}$ ", gave the shaft a speed of 246 r.p.m. If a faster motor is used, pair it with a larger pulley to keep the speed of the shaft between 225 and 250 r.p.m.

Acting as a brake so the shaft can be stopped instantly when current is cut off, a piece of $\frac{1}{16}$ " by $\frac{1}{2}$ " steel is attached to the stand, as shown, so a hardwood block on one end runs in the groove of the original polishing-head pulley. A compression spring and wing nut apply variable pressure to the block, and a little oil will cause it to run smoothly in the groove.

For accurate counting, one spoke of the large pulley is drilled and tapped for a round-head machine screw, and a U-shaped piece of cold-rolled flat steel is attached to the stand so one end will just touch the screw head when the pulley is turned. This makes a clicking sound at every revolution, and the turns can be easily counted.

The chuck attached to the right-hand thread can be borrowed from a hand or breast drill if the threads fit. It grips a bolt that is carried through the form on which the winding is done.—HAROLD P. STRAND.

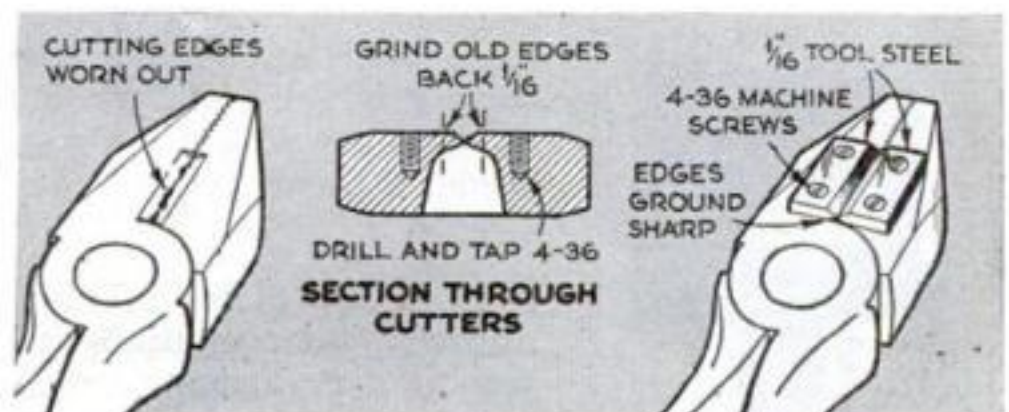


New Shopmade Blades Lengthen Life of Side-Cutting Pliers

WIRE-CUTTING pliers of the type generally used can be made to last longer if worn-down, useless side blades are ground back carefully beyond the gripping surfaces of the nose and a new, sharp set of blades is attached. If the side surface of the old cutters is rounded, grind it off flat, as shown below. Then draw the temper of the pliers and drill and tap for 4-36 steel machine screws, as shown, or for larger screws if the pliers are larger than 7".

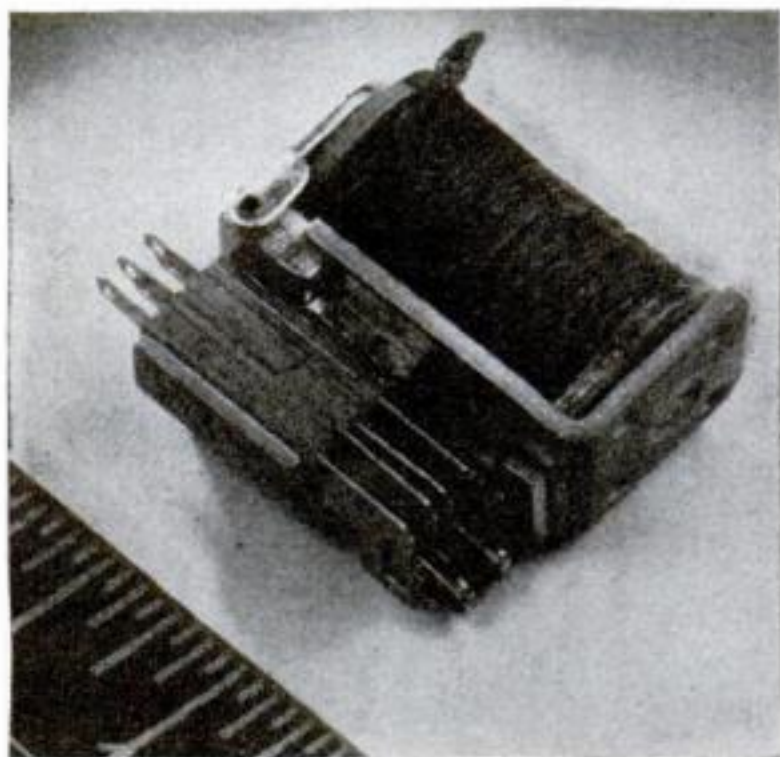
Make a pair of new blades from $\frac{1}{16}$ " tool steel, shaping them as shown. Then grind one side of each, as indicated, and drill holes for the screws. Next, temper the blades and retemper the pliers; then attach the blades, as in the

drawing, to finish the job. An extra set of blades can be made at the same time and kept in reserve to replace the others when they become so worn that they can no longer be ground for sharpening. Thus equipped with removable blades, the pliers can be given almost unlimited life.—H. P. S.



radio ideas

PUPPETS COME TO TELEVISION with the appearance of "Presto," magician of the air waves. He entertains television audiences with flights through space, queer antics by his sponsor's product, rides on his magic carpet, and, of course, the old East Indian rope trick. Created by Austin O. Huhn, of the Television Workshop, Inc., New York, for station W2XWV, "Presto" is worked out in tones of gray because colors do not register on the television camera as seen by the human eye. Materials in the clothing have a sheen that stands out against a nonreflecting background. The creator of this television puppet also produced "Clarence," the wireless robot at the New York World's Fair (see P.S.M., p. 70, Aug., 1940).



LIGHTWEIGHT RELAYS measuring barely more than $1\frac{1}{2}$ " in length have been developed for use in aircraft, giving service unaffected by plane vibration, extremes in temperature, or humidity. Contact springs made in a new shape by the Automatic Electric Company provide maximum flexibility in small space, keeping power requirements low, while a brass "pillow-block" brings a bearing surface to the entire length of a pivot-pin armature bearing.



BALLAST REGULATION of current and voltage on a fixed load is possible with the automatic-rheostat tube shown at left. This tube, made in sizes for use with maximum loads of 5 to 40 watts, consists of an iron wire sealed in a hydrogen or helium bulb. Large variations in resistance for relatively small current changes are caused by the high temperature coefficient of the wire, while rapid cooling of the gas flattens or extends the regulation. The tube may be used on either A.C. or D.C.



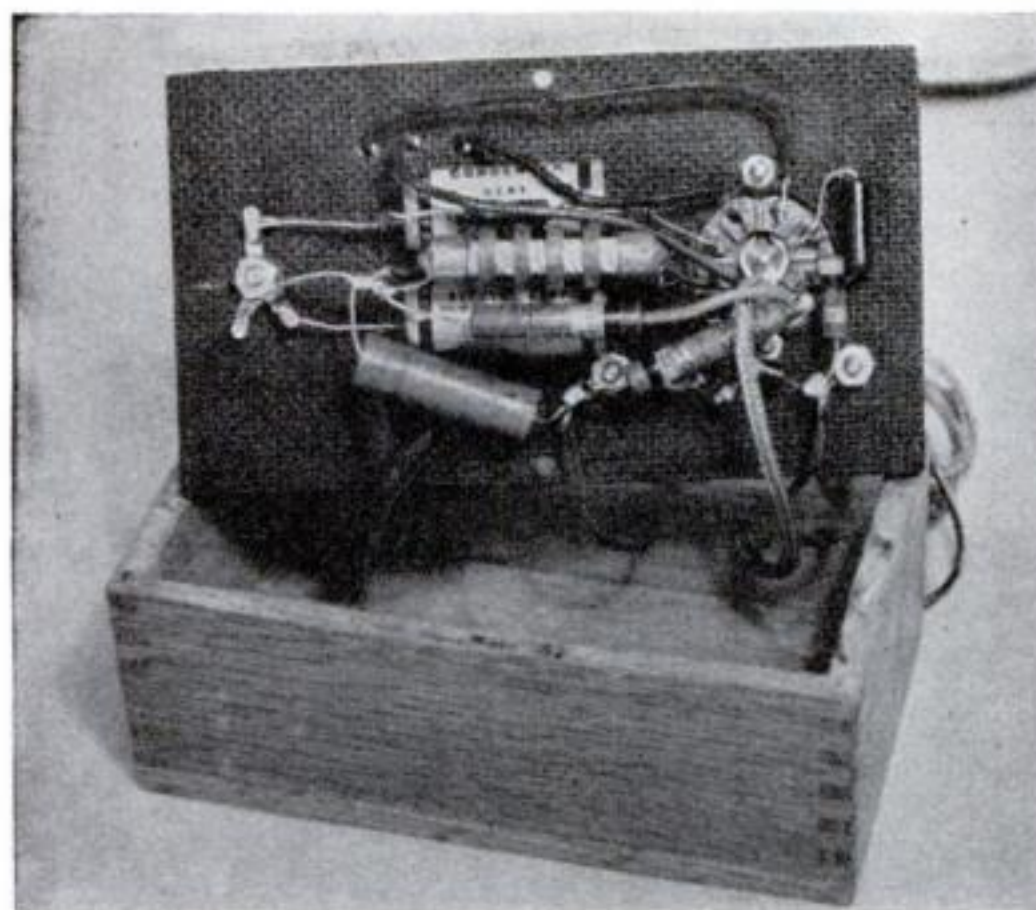
TINY COMMUNICATION SPEAKERS (at right above) are made for military radio equipment by mass-production methods with almost jeweler's precision. Among the extremely small parts required in these Magnavox speakers are windings finer than human hair.

AUTOMATIC VOLUME CONTROL

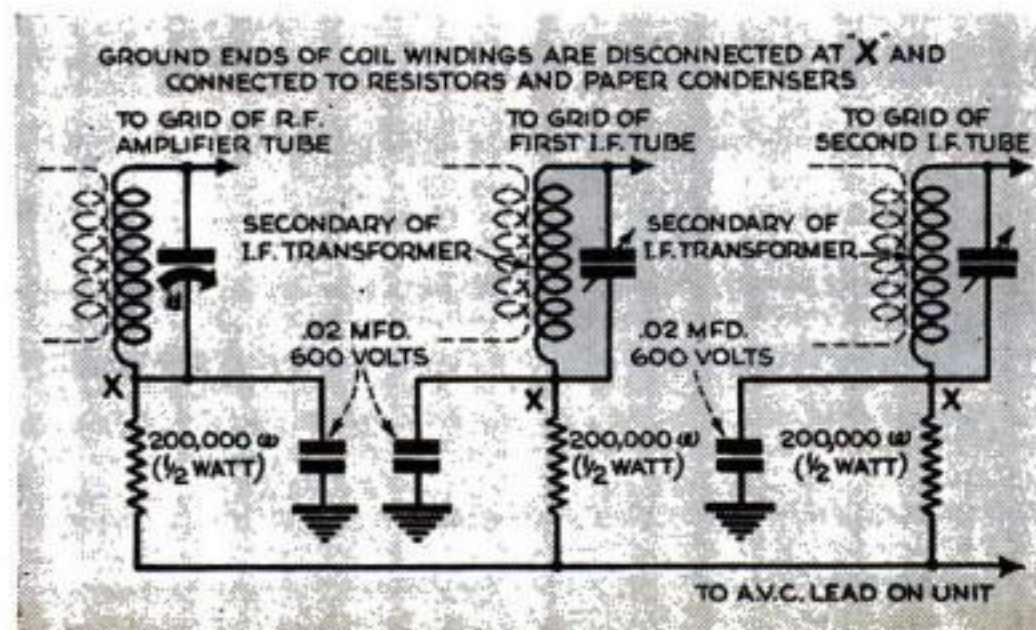
Duplex-Diode Unit Modernizes Old Superhets



Top and bottom views of the panel of the A. V. C. unit show the set connections and wiring. The 2" high base is sawed from a small card-index cabinet



Changes necessary in the old radio set to permit its use with the duplex-diode unit are simple to make and are shown fully in the diagram below. A wiring diagram of the unit itself is at the right



"Servicing Your Radio"

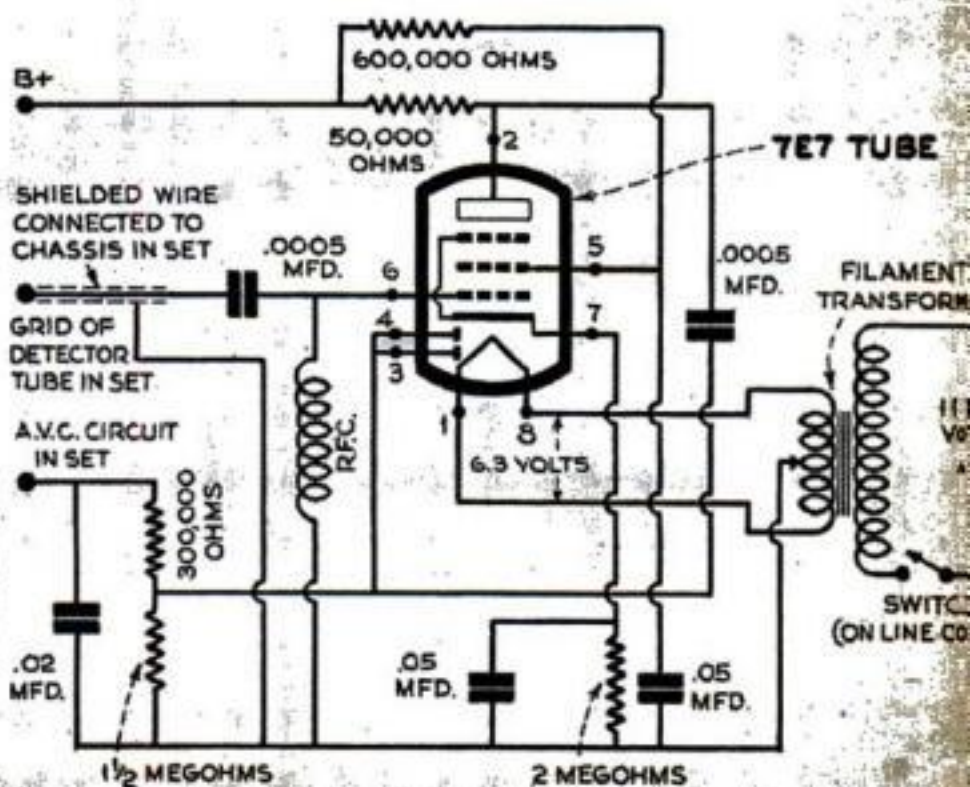
MANY console and midget superheterodyne radios have no automatic volume control. Most of them are 10 to 15 years old and were designed before duplex-diode detector tubes made A.V.C. possible even in inexpensive sets.

A.V.C. helps to keep a receiver from fading continually and also helps to avoid "blasting" from powerful local stations. Best results will be obtained if the receiver to which this unit is attached has one R.F. stage and one or two I.F. stages.

Duplex-diode detector tubes contain two diodes and a triode or pentode amplifier. One diode is usually used as the detector, the other for the A.V.C. circuit, and the triode or pentode as the first audio-amplifier tube. The unit shown was designed for a 7E7 tube, but any duplex-diode pentode type will do provided a transformer affording the correct heater voltage is selected.

The tube socket and filament transformer are mounted on a wood or composition panel set over half of a card-index box. All condensers and resistors are mounted underneath. Shielding is needed only on the grid lead to the set.

In operation the unit acts as a resistance-coupled I.F. amplifier generating its own A.V.C. current. If used with an A.C. receiver having a power transformer with a 6.3-volt heater tap, the filament transformer can be dispensed with and the heater current for the extra tube tapped directly from the set. The unit will operate only on A.C.



Dear Editor:
 What do you advise as a
 sewage-disposal system for a
 rural home that has plumbing
 facilities? Is it possible for the
 amateur to construct his own
 equipment?
 H.D. R.F.D. Richmond, Ind.

By E. W. LEHMANN

Head of Department of Agricultural Engineering,
 University of Illinois

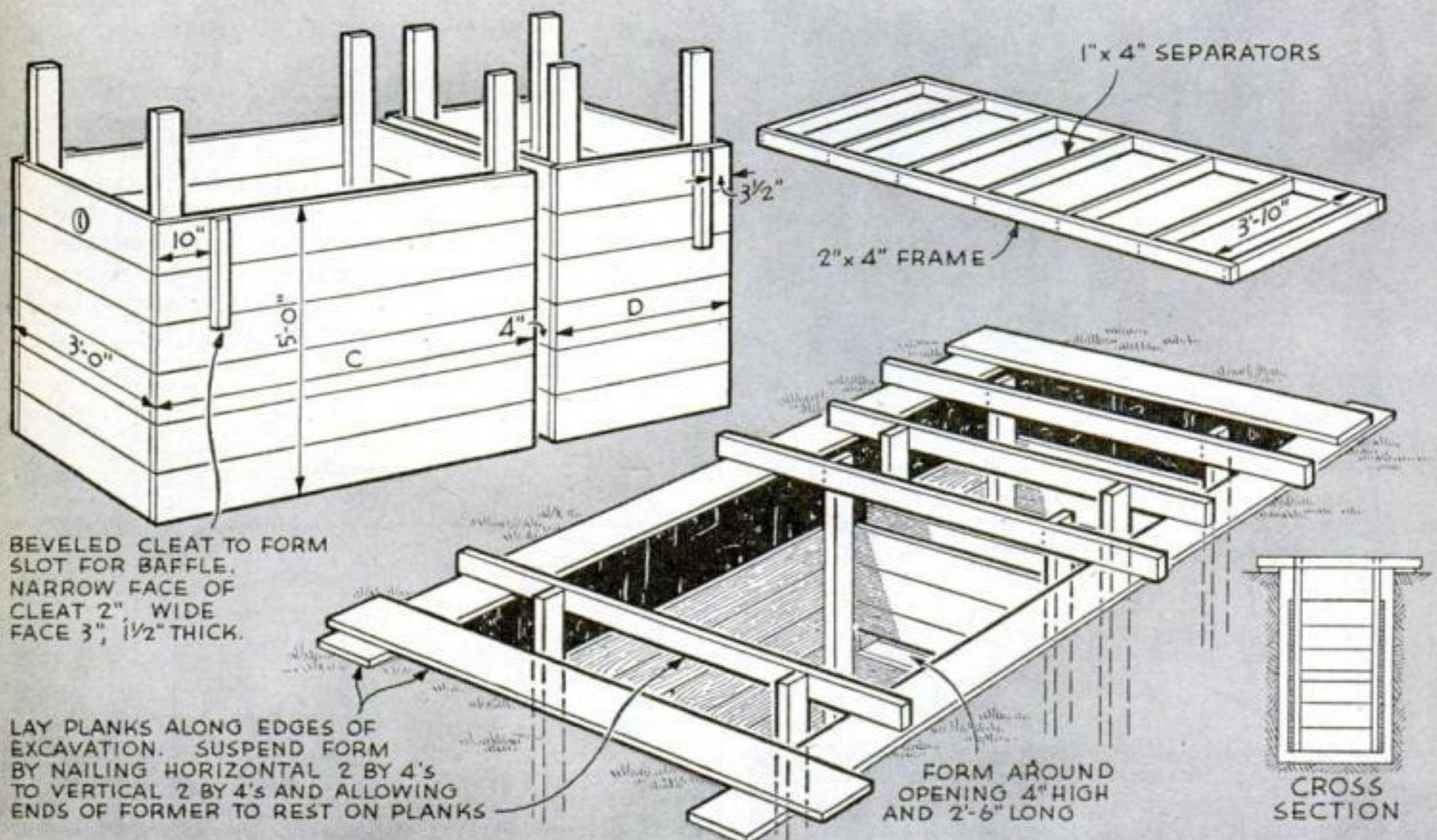
PROPERLY designed, a septic tank is a solution to the problem of sewage disposal for farm and other rural homes equipped with a water system and complete plumbing. The tank illustrated is a two-chamber type, with the first chamber twice as large as the second. Although many tanks are made with only one chamber, the extra expense of the two-chamber disposal system is amply justified by added efficiency of operation and by eliminating the necessity of frequent cleaning.

Results of experiments conducted at the University of Illinois Agricultural Experiment Station indicate that a tank 3' wide and 4' deep with chambers 6' and 3' long has adequate capacity for a family of seven.

No tank should be smaller than this. Recommended sizes to serve larger numbers of persons are given in the table. Also given there are the amounts of cement, sand, and gravel or crushed stone required for the various sizes of a tank of the design shown. Since in many communities it is economical to have ready-mixed concrete delivered from a mixing plant, the amount of mixed concrete needed is also given. Brick may be used for the construction if desired, but it should be plastered on the inside with cement mortar to make it watertight.

Satisfactory forms for pouring concrete can be made of wood as shown in the drawings below. There are communities, however, where materials dealers have forms already constructed, and in some sections, especially in the Middle West, some county agents have forms for rent. When forms are used more than once, this will, of course, greatly reduce the cost of each tank, but care should be taken to build them so they can be easily removed without damage. Metal construction increases the life of such forms.

Locate the tank well away from the water supply. If this happens to be a well, it is best to have both the tank and disposal lines on a downward slope and at least 75' away if possible. Excavate the hole so the earth wall will serve as the outer form, and place planks around the top to prevent cav-



ing. Set the forms in place, supporting them at the proper height. As the concrete is poured in the sides, the floor will be built up by leakage under the forms and by material spilled on the inside, but more concrete may have to be added on completion.

It is well to keep the concrete at the same height on all sides as it is being poured, and tamp and spade it carefully to avoid pockets. For best results, complete the job in one operation. Do not extend the wall up to the ground level—a few inches above the inlet tile is sufficient—and do not let the floor come up above the bottom edge of a form, since this will make the form difficult to remove when the concrete hardens.

Make the cover in sections—reinforced concrete slabs not more than 18" wide—for easy handling. They can all be made at one time in a gang mold, as shown. Heavy building paper laid on smooth ground or a concrete floor will serve for the bottom of the mold. Have the slabs long enough to extend over the walls of the tank, and use steel rods for reinforcement.

An inspection tile should be provided over the inlet and should extend to the surface of the ground. No such tile is necessary over the outlet.

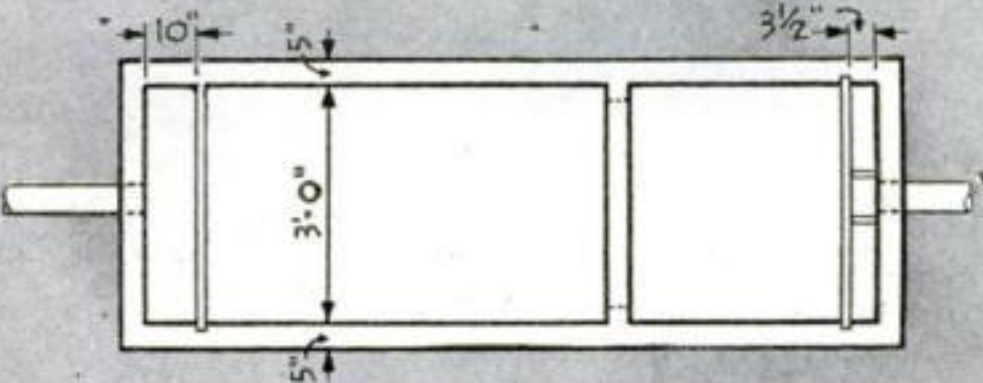
Construct the sewer line between the house and the tank of standard bellmouth sewer tile or of cast-iron soil pipe to be absolutely watertight. The joints of the bellmouth tile should be sealed with a dense

mixture of cement mortar, and standard lead seal is used with iron pipe. Take particular care where there is any danger of contaminating the water supply.

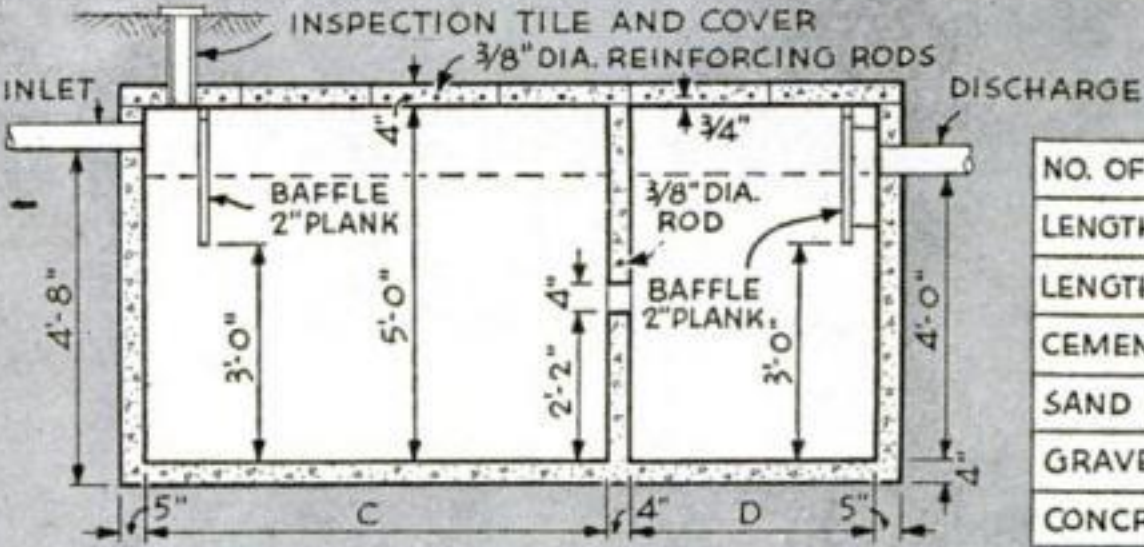
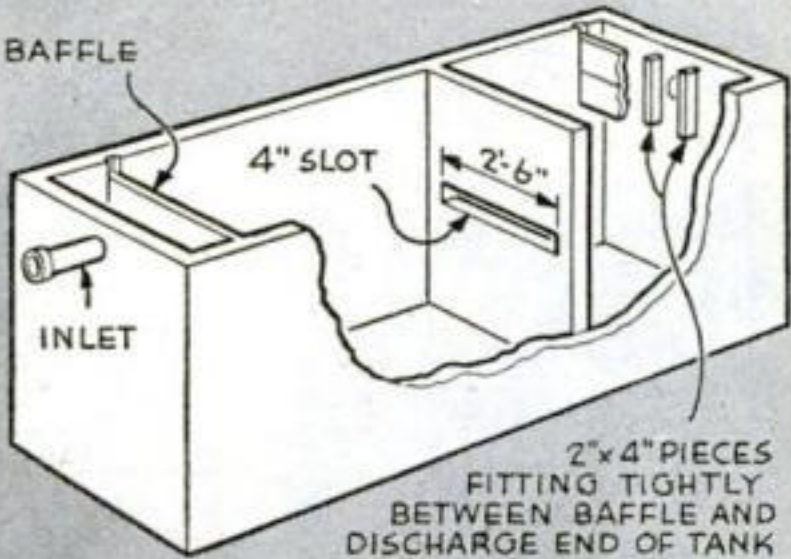
Since the principle of a septic tank lies in the changing of solids into liquids by the action of friendly bacteria working between a top scum and silt at the bottom, there will be only liquid to be finally disposed of at the outlet. This disposal is best accomplished through subsurface open-jointed farm drain tile laid at a depth of 12" to 16" on a slightly downward grade from the tank. The length of discharge tile needed depends upon the porosity of the soil and the number of persons served by the tank. Ordinarily 30' to 40' per person is sufficient.

Where the soil is tight and nonabsorptive, the length of discharge tile should be increased, and a layer of sand or gravel next to the tile will aid seepage. If the length is more than 200', lay two branches at least 12' apart. If the ground is extremely non-porous, additional tile parallel to and slightly below the subsurface lines will take away seepage that passes into the soil. For good distribution, have the slope of the first half of either a single or double line about 8" in 100'; lessen the slope for tight soil.

Maintenance under normal conditions is not a serious matter. A tank of adequate size should operate 10 years or longer without cleaning, but an inspection is advisable after seven or eight years.



PLAN WITH COVER REMOVED

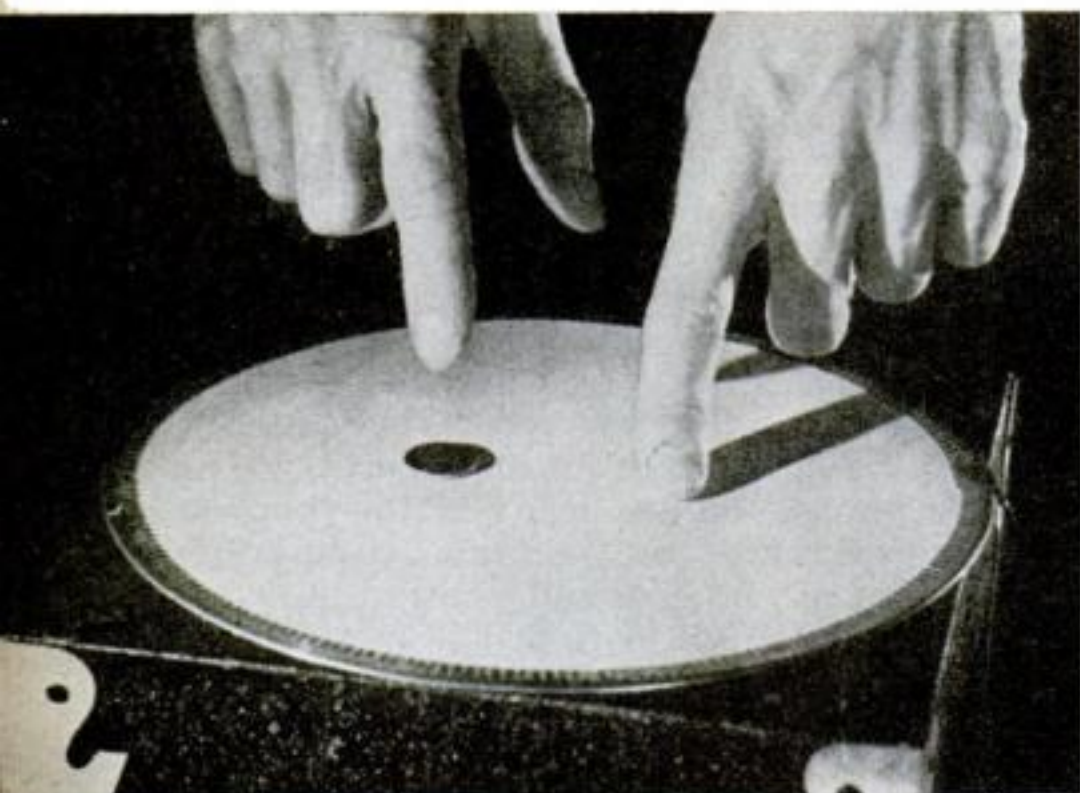


LONGITUDINAL SECTION

NO. OF PERSONS	7 OR LESS	9	12	15
LENGTH CHAMBER C	6'	7'	8'	9'
LENGTH CHAMBER D	3'	3 1/2'	4'	4 1/2'
CEMENT (BAGS)	20	22	24	26
SAND (CU.YDS)	1 1/2	1 2/3	1 3/8	2
GRAVEL (CU.YDS)	3	3 1/4	3 1/2	3 3/4
CONCRETE (CU.YDS)	3 3/8	3 1/2	3 3/8	4 1/2

DIMENSIONS & MATERIALS REQUIRED

HOME EXPERIMENTS WITH HEAT

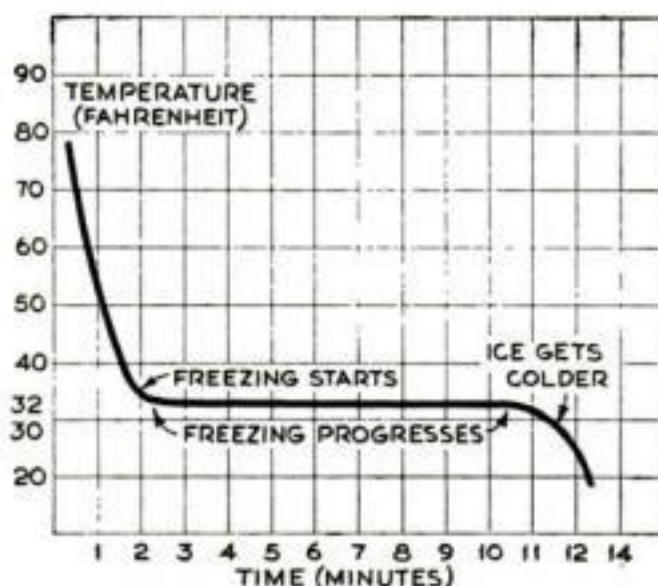


WATER BOILED ON A CARD makes an amusing stunt that will perplex your friends. Take an ordinary visiting card and fold up the corners so that it becomes a sort of dish. Now pour in a little water, and then hold the improvised "kettle" over a lighted match. The water will actually boil, and yet the card will not catch fire and burn. This is because of a very simple reason: the boiling water conducts heat away from the card so fast that the card can never get hot enough to burn. Using the same or a similar card, and exercising great care, you can also melt a small amount of tin or lead foil.

YOU CAN TOUCH HOT ASBESTOS, but metal at the same temperature will make you draw your finger away. Put asbestos mat over a low gas flame or an electric grill and lay a penny on it; then periodically touch the penny with one finger and the mat with another. Soon the penny will be too hot to touch although you can still touch the asbestos. Why should more heat come through the mat at one place than at another? It doesn't. A thermometer will show that both the penny and the mat are at approximately the same temperature—the difference is in heat conduction. Metal conducts heat rapidly to your finger, while asbestos holds it back. One makes a good radiator; the other insulation.



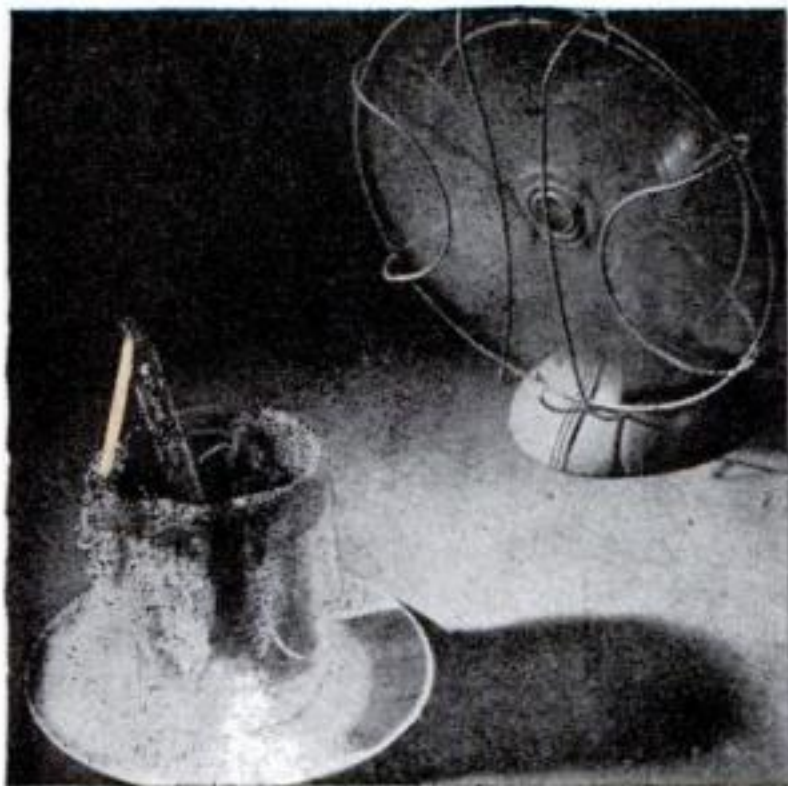
HEAT LIBERATED DURING FREEZING keeps temperature from changing until a mass of water has become solidly frozen. Stand a thermometer in a test tube half filled with water and put the test tube in a glass of cracked ice mixed with salt. Then plot a graph relating time and temperature change as shown below. The temperature of the water in the test tube will drop uniformly until it reaches the freezing point—0 deg. C. or 32 deg. F. At this point the water begins to freeze and the temperature will not vary a frac-



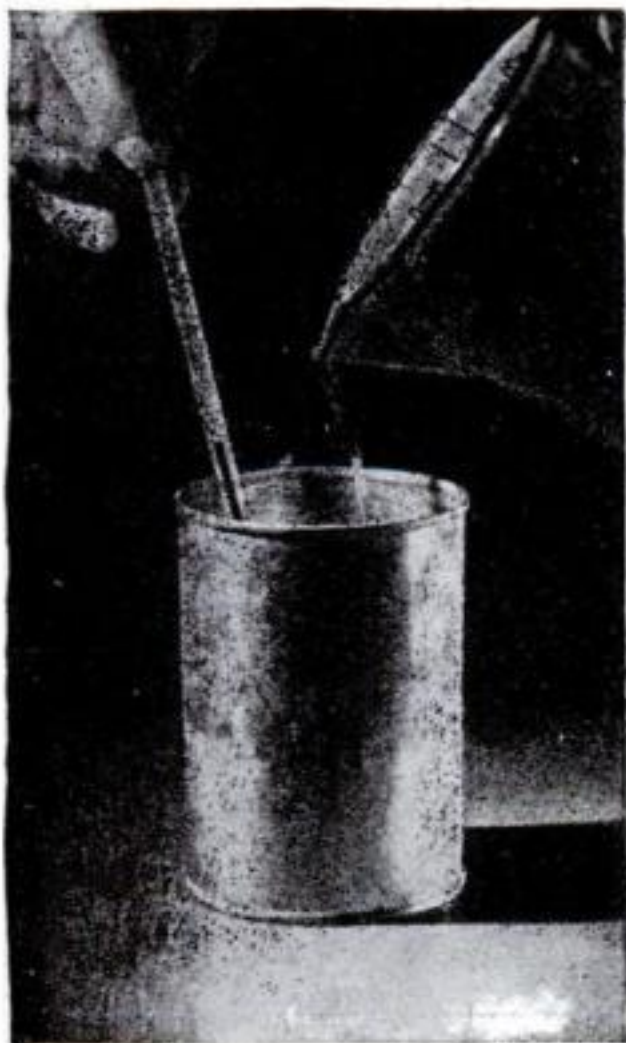
tion of a degree for some time; but after the water has completely frozen, the temperature will again drop a few degrees. What happens is that during freezing sufficient heat is liberated by the water to keep it at the freezing point. It takes 80 calories of heat to melt a gram of ice; likewise a gram of water loses as much during freezing.

AND COLD

WHY A BREEZE COOLS a person in it and yet does not cool the room can be shown with an electric fan, a can of water, a few pieces of cloth, and a thermometer. Hold the thermometer in the breeze of the fan, and it does not change; but place it in the water and let the fan blow on the water, and the temperature will drop. If you trail pieces of cloth from the water over the sides of the can, the temperature will drop still further. A breeze helps to evaporate water, and this cools the air. Evaporation of perspiration cools your body.



A MODEL GAS FACTORY can be built by rolling a newspaper into a cone and inserting a glass or metal tube in the small end. Light the large end, and you will find that you can ignite the smoke that pours from your "gas jet." This smoke consists of unburned carbon and hydrocarbon gases. Much illuminating gas is made by heating coal away from air.

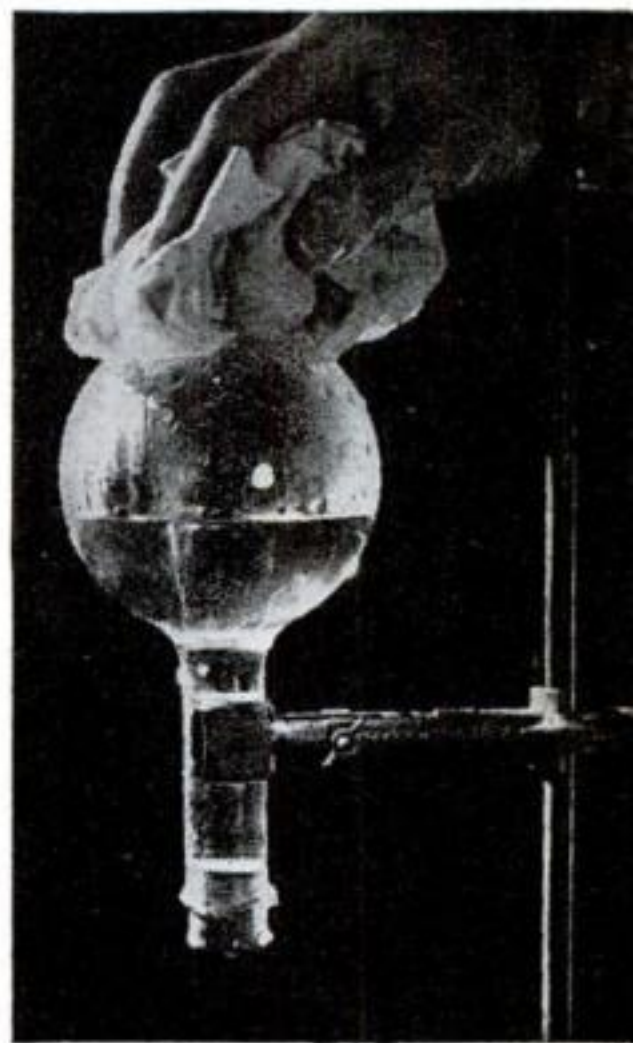


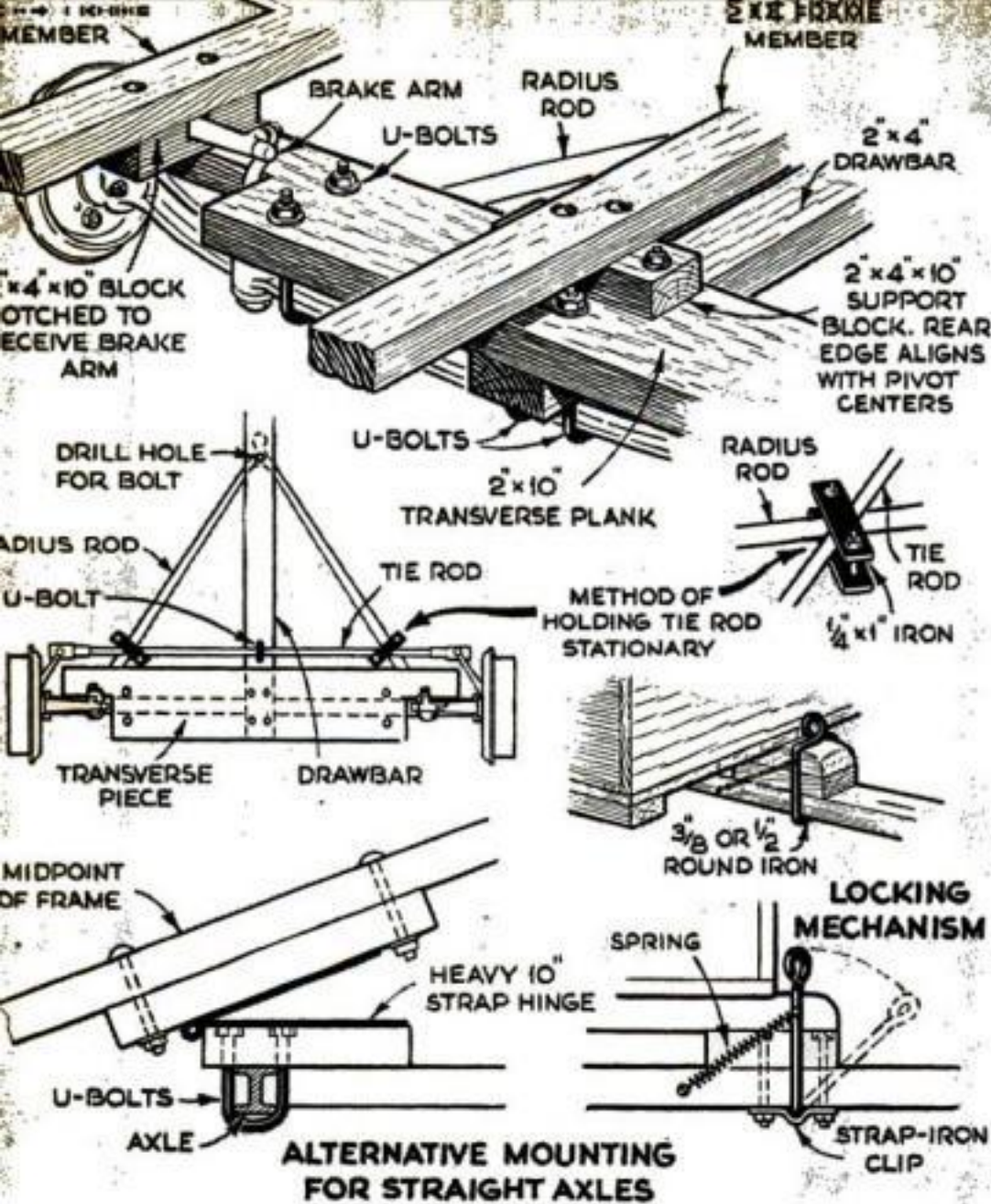
HOW WATER IS SQUEEZED

from humid air can be shown by putting an inch of water at room temperature in a bright tin can and slowly pouring and stirring ice water into it. Note the temperature at which "sweat" begins to form on the can. This is the "dew point" at which rain would be precipitated from similarly partially saturated air.

WHY WATER BOILS

at lower temperatures in high altitudes may be seen by half filling a flask with water, bringing it to a boil, and stoppering it when the boiling has subsided. Invert the flask, apply an ice-soaked cloth to the upturned bottom, and the water boils again because reduced pressure caused by condensing the steam lowers the boiling point.





Pulled behind a small tractor, this dump box is useful for farm hauling

With its locking mechanism tripped, the box can be upset to dump its load



Dump Trailer for Farm Tractor Built on Discarded Car Axle

THIS piece of equipment that will find many uses on the farm is a simple box of 1 1/4" fir flooring and 1" by 12" pine sides with a removable backboard. It is mounted on the trailer chassis either on blocks or a heavy hinge, as shown in the drawings. For hauling, the box is held to the drawbar of the trailer by a locking mechanism; in dumping, the catch is tripped and the tractor moved forward a short distance to upset the load. The dump box pictured is 7' 6" in length and slightly under 4' in width.

Construction of the trailer chassis will vary somewhat according to the type of axle available. That in the drawing is designed for the front axle of a Model A Ford.

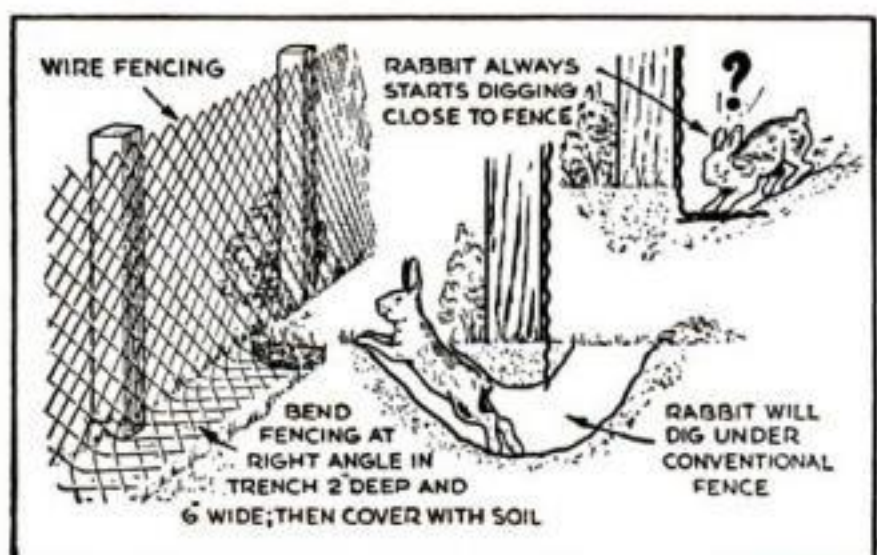
Mount on the axle a piece of 2" by 10" stock held with U-bolts drawn tight. A 2" by 4" piece of ash or other hardwood stock is bolted rigidly to this board for a drawbar. Radius rods are bolted to the underside of the drawbar, attached at the axle end as shown, and held with a tie rod.

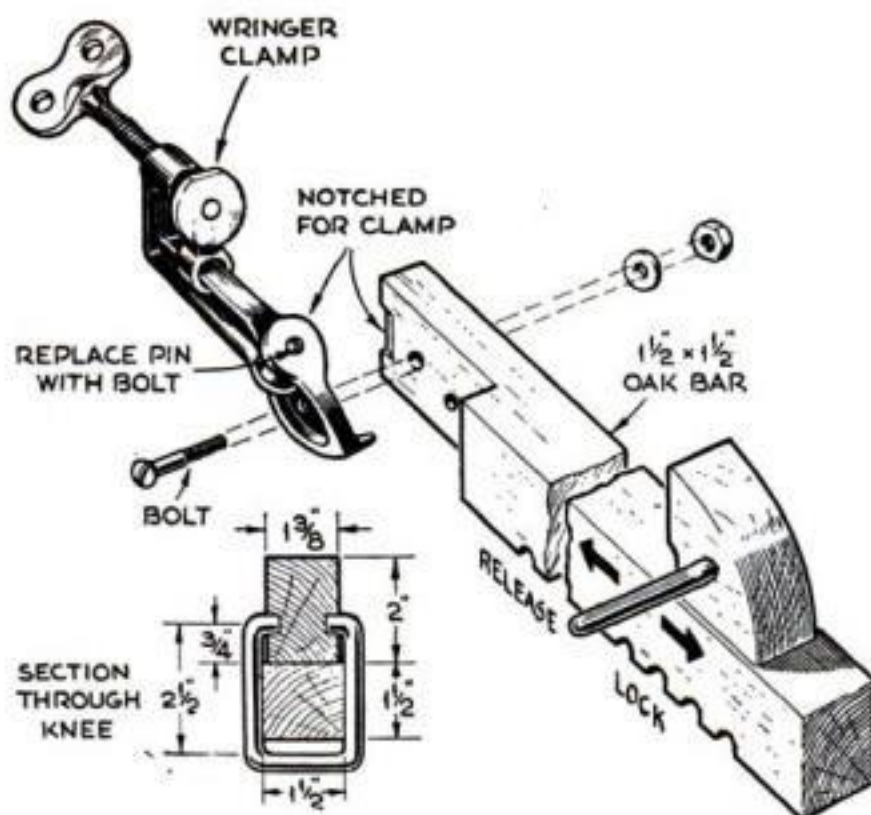
Strength will be added to the dump box by attaching it to a frame that may be built of three lengthwise pieces of 2" by 3" hardwood and four crosspieces of the same stock. Cut the center lengthwise piece slightly longer than the other two so that it will project slightly at the front of the box. This provides a place for the locking mechanism shown here.—RALPH S. WILKES.

Underground Wire Fence Keeps Rabbits Out of the Garden

RABBITS and dogs can be kept out of the Victory garden by an easily constructed wire fence with a shelf or apron under the ground. The bottom portion of the wire, bent away from the garden, is placed flat in a shallow trench, then covered with soil.

For 36" chicken wire, make a 6" shelf 2" below grade. The 28" above ground is too high for the average neighborhood dog to jump over. Rabbits invariably tunnel close to the bottom of a fence, and they will be immediately stopped by the underground wire shelf.—H. S.





Part of Old Wringer Is Used in Making Bar Clamp

IRON clamps from an old wringer can be used on $1\frac{1}{2}$ " by $1\frac{1}{2}$ " oak or other hardwood stock to make a pair of bar clamps that will apply ample pressure to furniture or other home-workshop gluing projects. Cut the oak the desired length and shape and notch one end, as shown above, to align the screw head of one clamp with the center plane of the bar. The swivel joint may be left as it is or locked by replacing its loose pin with a bolt and washers.

Shape the adjustable knee from hardwood and drill it for a locking device bent from $\frac{1}{4}$ " iron rod to the form of a square-cornered O with a $\frac{1}{2}$ " opening at the top. A $7\frac{1}{2}$ " rod will be long enough to let the O fit loosely and yet lock in the proper notch when the knee is pressed back. Notches can be made on a pair of clamps at one time by clamping the bottom faces of the two bars together and drilling through the joint with a $\frac{3}{8}$ " bit.

Varnish the bars and paint the iron clamps and knees black—FRANCIS L. TYLER.

Kitchen Cleanser Helps Remove Painted Signs on Truck Body

OLD signs painted on a newly purchased secondhand truck can be removed with a cloth dipped in a solution of alcohol, lacquer thinner, and kitchen cleansing powder. Rub only the letters. The method is not advisable if the body paint is thin. Splotches of paint that have dried on enameled work can be removed by rubbing gently with a wet cloth on which some cleansing powder has been sprinkled lightly.—JOSEPH E. BIRD.

Cut-Film Holders Are Identified with Strips of Marked Tape

CELLULOSE and similar tape having an adhesive surface that can be used several times make excellent identifying tags for cut-film holders when cut into short strips and labeled in ink with the name of types of film used. Strips may be stuck on holders in one position to indicate fresh film and in another to show it has been exposed. A "file" may be kept by sticking strips on metal or glass.

Cases for cut-film holders can be made from an old suede jacket or heavy duck. Cut the material $\frac{3}{4}$ " longer than twice the width of the holder and $\frac{1}{2}$ " longer than the length; then fold it, stitch two adjacent sides, and turn it inside out.—J. W. C.

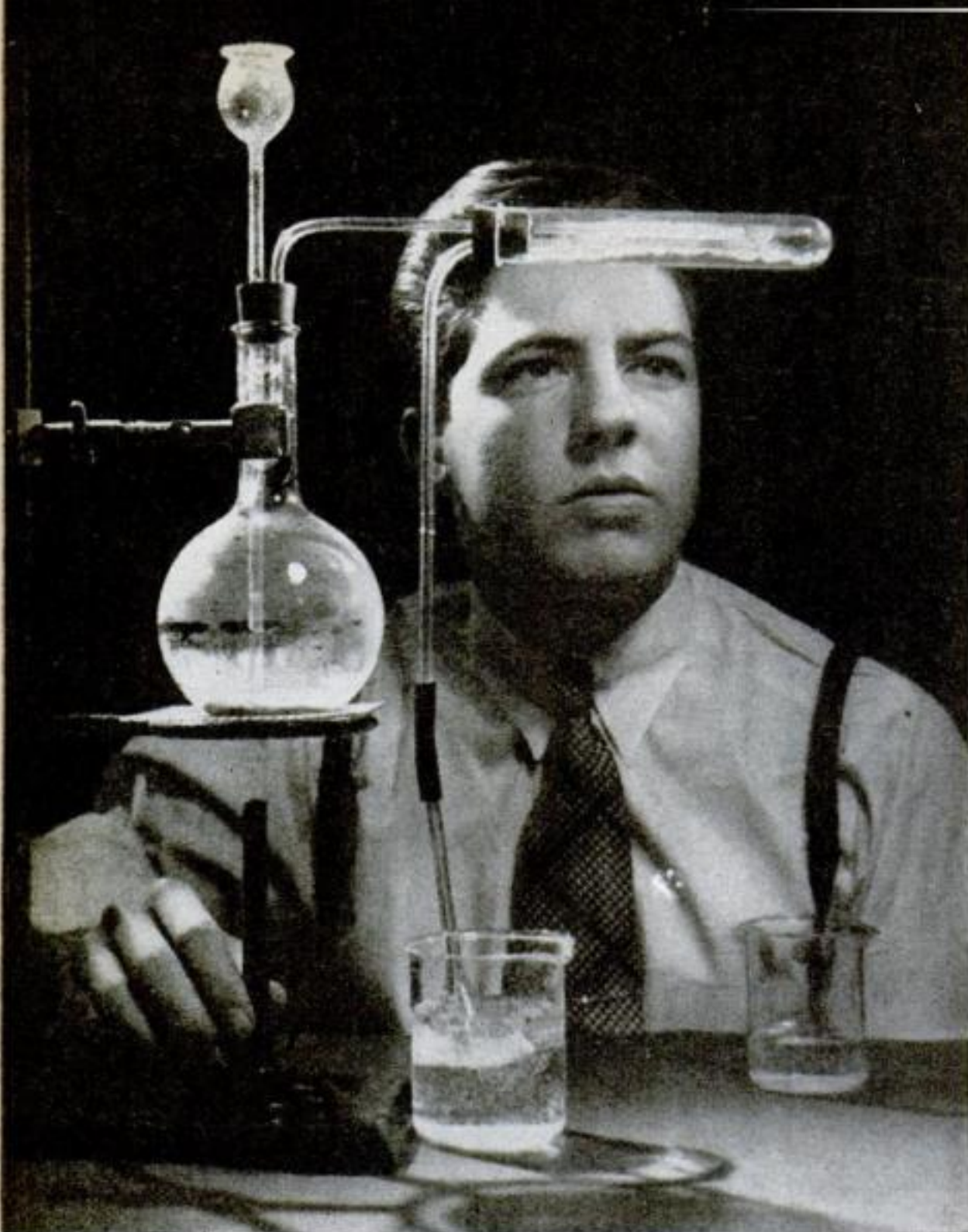


Compass Used to Cut Circle

HELD to the inking leg of a draftsman's compass by the regular adjustment nut and stud, a double-edged razor blade will cut circles in paper and cardboard for decorations, camera filter mounts, novelties, and the like. The blade is easy to assemble on the inking leg and is as readily removed.

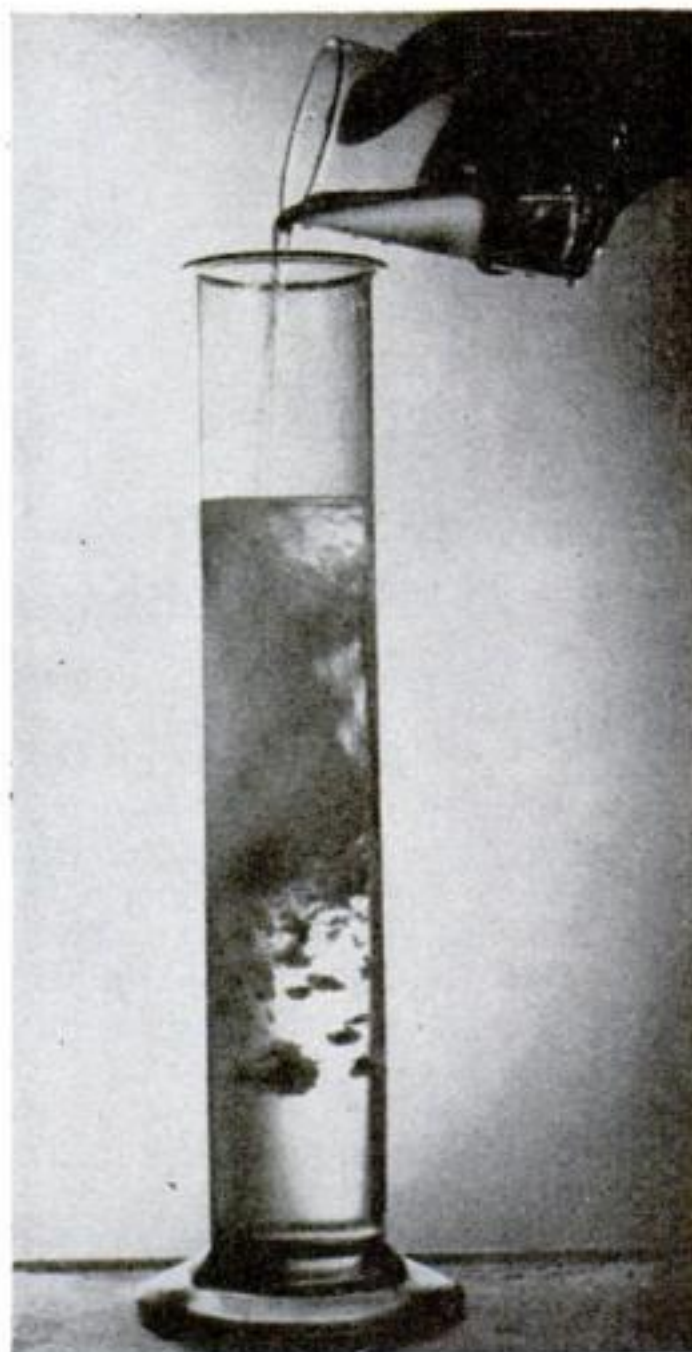
When a blade becomes dulled at one corner, shift its position in order that another corner can be used.—ROBERT SCOTT.





"Chloride of lime" bleach is made as at left by passing chlorine gas over slaked lime in the test tube to get calcium hypochlorite powder

Dilute sodium carbonate added to a solution of calcium chloride forms a finely divided precipitated chalk



Calcium

....THE BUILDER'S ELEMENT

Mortar, marble, and plaster are in the same family of compounds that gives you teeth and bones

By KENNETH M. SWEZEY

FEW people have ever seen the silver-white metallic element calcium, for it never occurs free in nature and its commercial application is extremely limited. Its compounds, however, are among the most abundant and important chemical substances.

Mortar made of slaked lime, or calcium hydroxide, was used more than 5,000 years ago to build the pyramids of Egypt just as it is used today. Limestone and marble, sea

shells and coral reefs, the great chalk cliffs of Dover, crystal caves, double-refracting Iceland spar—all are forms of calcium carbonate. Calcium hypochlorite is the well-known "chloride of lime." Gypsum and plaster of Paris are calcium sulphate. Largely as material for teeth and bones, calcium phosphate makes up about 1.5 percent of your body weight.

Sir Humphry Davy named calcium from the Latin *calx*, which means chalk. Chalk cliffs and beds are composed chiefly of the compacted skeletons of microscopic marine animals. Powdered chalk is the "whiting" used as a filler in rubber and other products, as an abrasive, and as a pigment extender for paints. Precipitated chalk, the principal ingredient in most tooth powders and pastes,

is produced by means of chemical reaction.

With the help of any soluble calcium salt and any soluble carbonate, you can demonstrate how chalk is precipitated. Calcium chloride and sodium carbonate are the chemicals generally used commercially. Make a warm, dilute solution of each and pour one into the other. The white dense cloud that forms is finely divided calcium carbonate. Allowed to stand undisturbed, the chalk will settle to the bottom. It is purified by repeated washings and decantation.

Substitute cold, concentrated solutions of calcium chloride and sodium carbonate for warm, dilute ones, and you can perform a curious feat of chemical magic. Mix these two with gentle but thorough stirring, and the result is a jellylike solid. Continue stirring for a few minutes, and the mass turns into a milky liquid. Let it stand a few minutes longer, and the white coloring material settles to the bottom once more as precipitated chalk.

Limestone, one of the most abundant forms of calcium carbonate, is the source of the millions of tons of "quicklime" (calcium oxide) and "slaked lime" (calcium hydroxide) needed yearly for mortar, plaster, cement, and the neutralizing of acid soils. The limestone is broken and heated to high temperature in huge furnaces or kilns until carbon dioxide is driven off.

You can duplicate this with a chip of limestone or marble and a Bunsen flame. Twist a piece of iron wire around the chip and hold it in the hottest part of the flame for several minutes. Then dip it into water containing a drop of phenolphthalein solution. The chip turns pink and colors the water, indicating that the neutral stone has



Cold, concentrated solutions of sodium carbonate and calcium chloride form a jelly, as at right. Stirring liquefies the mass and precipitates chalk

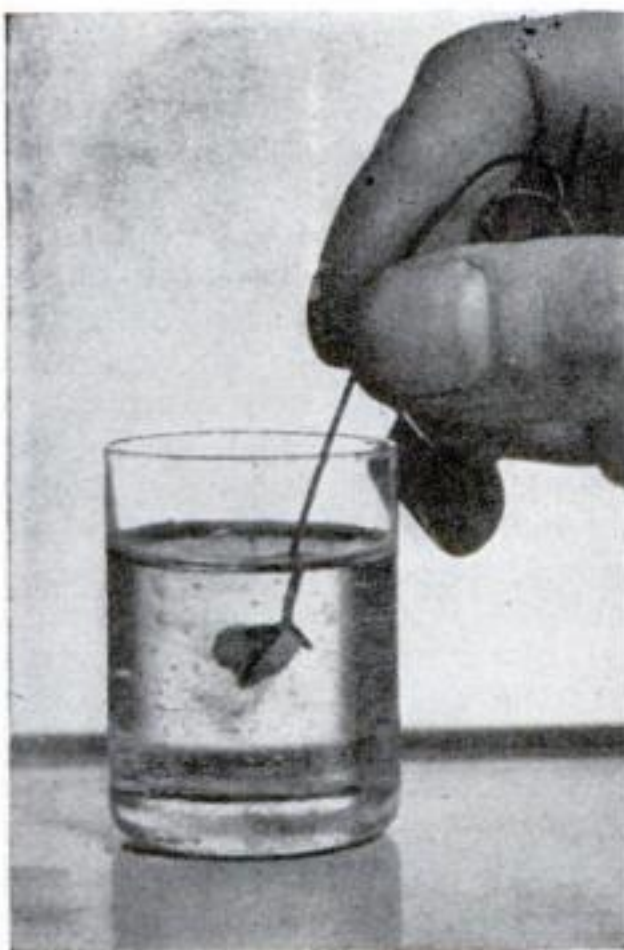
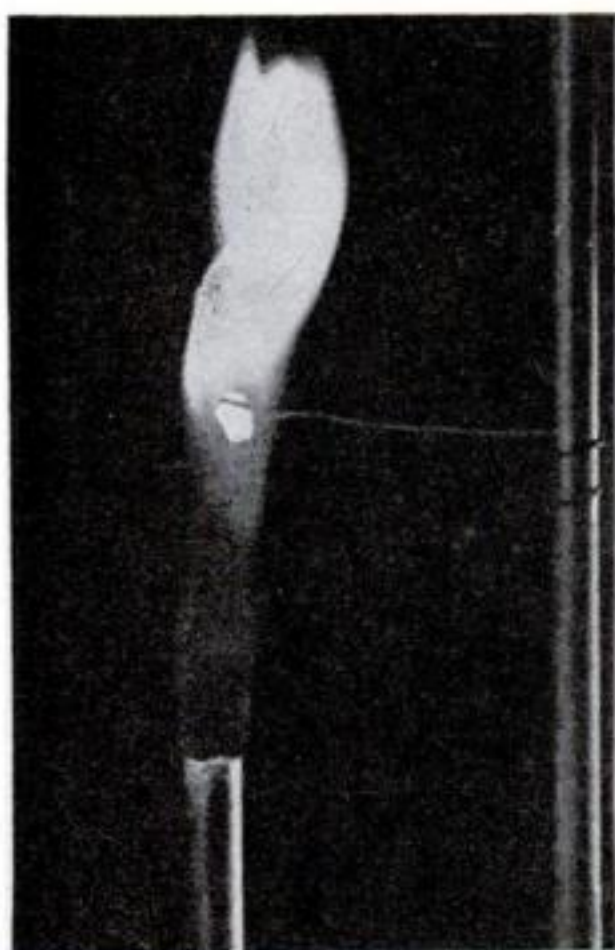
become an alkali. Driving off carbon dioxide changed the calcium carbonate into calcium oxide; then water in turn changed calcium oxide into calcium hydroxide.

The last compound, cheapest of all alkalis, is made by carefully adding water to quicklime until visible reaction stops. Pure calcium oxide will combine with about 30 percent of its own weight of water. Considerable heat and steam are produced in the process, and finally the calcium hydroxide collapses as a fine powder. Mortar is made by mixing slaked lime and water with sharp sand. It is hardened first as the water evaporates, and then during slow chemical change in which carbon dioxide in the air transforms the hydroxide into hard calcium carbonate.

Limewater is made by shaking a little slaked lime in water and filtering off the undissolved lime. To test for carbon dioxide, blow into the solution through a tube. It becomes milky as insoluble calcium carbonate is formed. Continue to blow, however, and the solution clears again because excess carbon dioxide changes the carbonate into soluble calcium bicarbonate.

The fact that calcium carbonate dissolves in water containing excess carbon dioxide accounts for giant

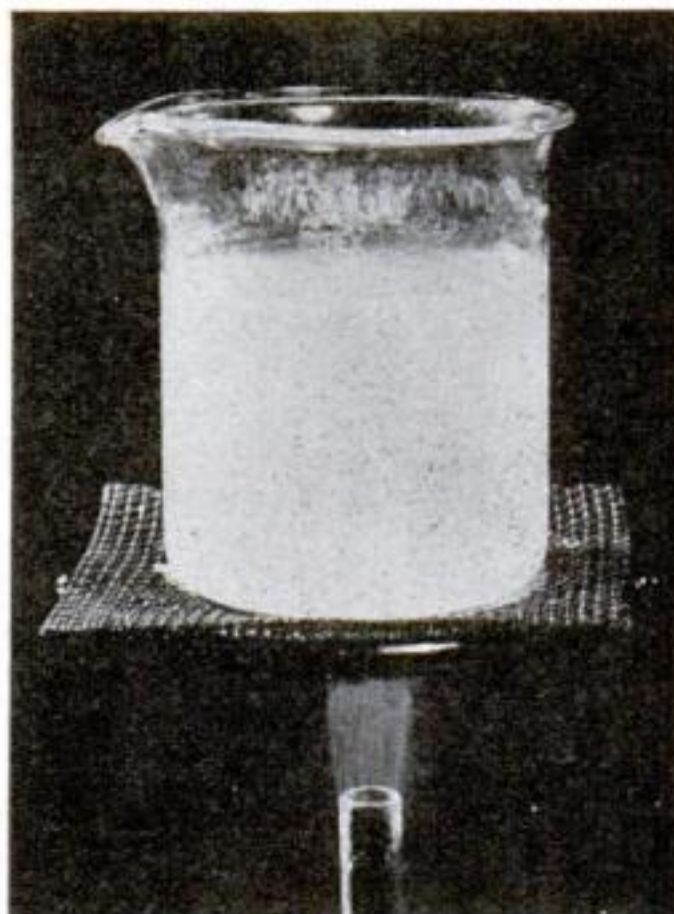
Heating in a flame drives carbon dioxide from a chip of limestone or marble, leaving calcium oxide (quicklime), an alkali that turns pink in phenolphthalein solution





"Temporary" hard water often contains calcium bicarbonate, picked up from carbon dioxide in the air and limestone. Temporary hardness is easy to get rid of by simply boiling water

Boiling liberates part of the carbon dioxide, and calcium carbonate is precipitated. After a short while, the new compound will settle on the bottom, leaving the water completely "soft"



limestone caves, the stalactites and stalagmites that "grow" in them, and certain types of "hard" water. Water containing carbon dioxide from the air and running through fissures in limestone rocks dissolves minute portions of the rocks. After centuries, the fissures grow into tunnels and then into caves. Iciclelike stalactites of stone hanging from the roofs of such caves are caused by the seeping through of water containing calcium bicarbonate and the subsequent evaporation, which leaves solid carbonate.

Water containing dissolved calcium bicarbonate is called "temporary" hard water because the "hard" calcium can be removed simply by boiling. Make temporary hard water by bubbling carbon dioxide gas (generated by the reaction of any carbonate or bicarbonate and acid) through limewater until the water has become white and then clear again. Boiling then drives off excess carbon dioxide in the calcium bicarbonate, precipitating calcium carbonate. Left to stand, the white carbonate settles, leaving the water free from calcium, or "soft."

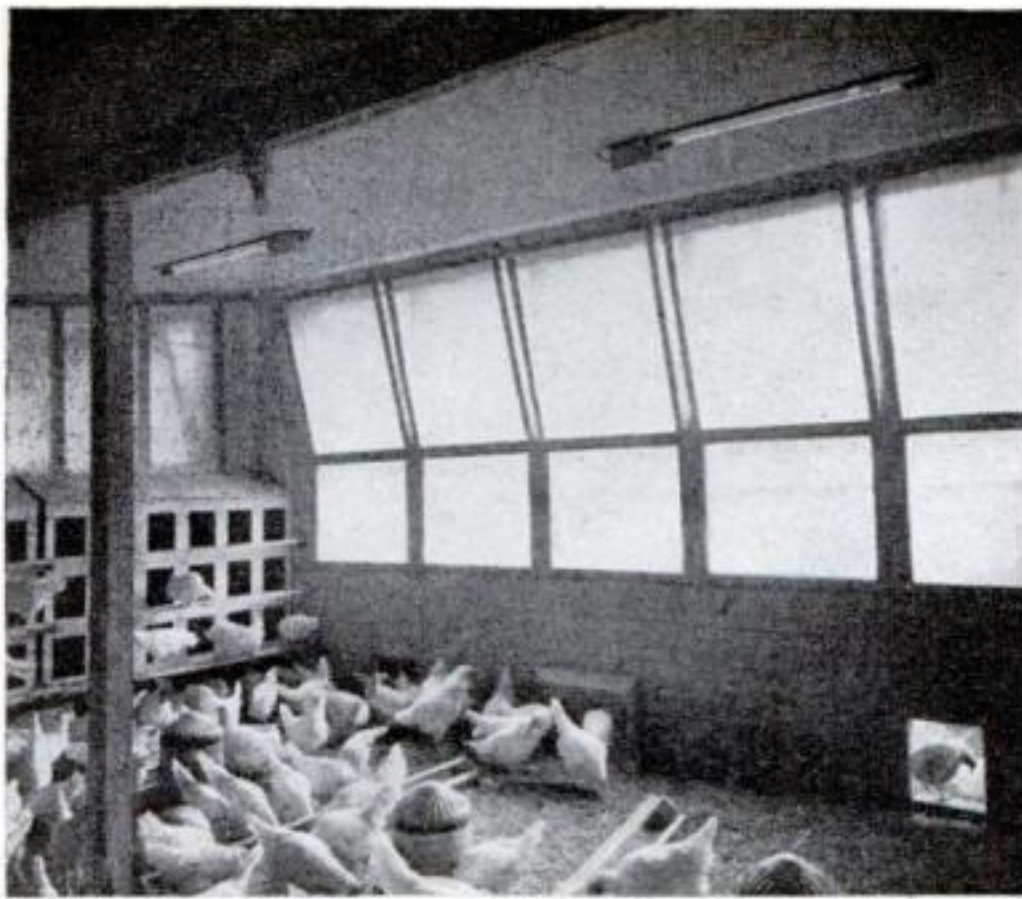
Sprinkle precipitated chalk (calcium carbonate) into a dilute solution of the desired acid until carbon dioxide stops bubbling, and you can make any calcium salt you need. With hydrochloric acid, the salt in solution is calcium chloride. Evaporate the water, and the compound forms needlelike crystals, which when heated in an evaporating dish become dry calcium chloride with an amazing affinity for water. This dehydrated calcium chloride is used in the laboratory to dry gases, and in damp cellars and closets to remove excess moisture from air. It is sprinkled on roads, tennis courts, and in the subways, to lay dust by keeping the earth damp with absorbed moisture.

Vast deposits of calcium sulphate occur in nature as gypsum—a dihydrate in which two molecules of water are combined with each molecule of sulphate. When gypsum is carefully heated to between 120 and 180 deg. C., three fourths of the water of crystallization is driven out, leaving a hemihydrate. This is "plaster of Paris," made first of gypsum from the slopes of Montmartre.

"Set" plaster can be changed back to plaster of Paris and made to set over again. Powder a little hardened plaster, spread it thinly on a can cover, and heat it in an oven for 10 minutes at 120 to 180 deg. C. Let it cool and mix it with water to make a stiff paste and in 20 minutes it will be rigid again.

Despite its name, household "chloride of lime" is vastly different from calcium chloride. It is technically calcium hypochlorite, a compound made by passing chlorine gas over thin layers of slaked lime. Put 10 grams granular manganese dioxide in a flask, as shown in the setup on page 184; add 25 ml. concentrated hydrochloric acid. Spread a thin layer of calcium hydroxide along the side of the horizontal test tube. Arrange a small inverted funnel so that its mouth barely dips below the surface of a dilute solution of sodium hydroxide (ordinary lye will do) in the beaker. This latter will absorb most of the excess chlorine and keep the gas from the room.

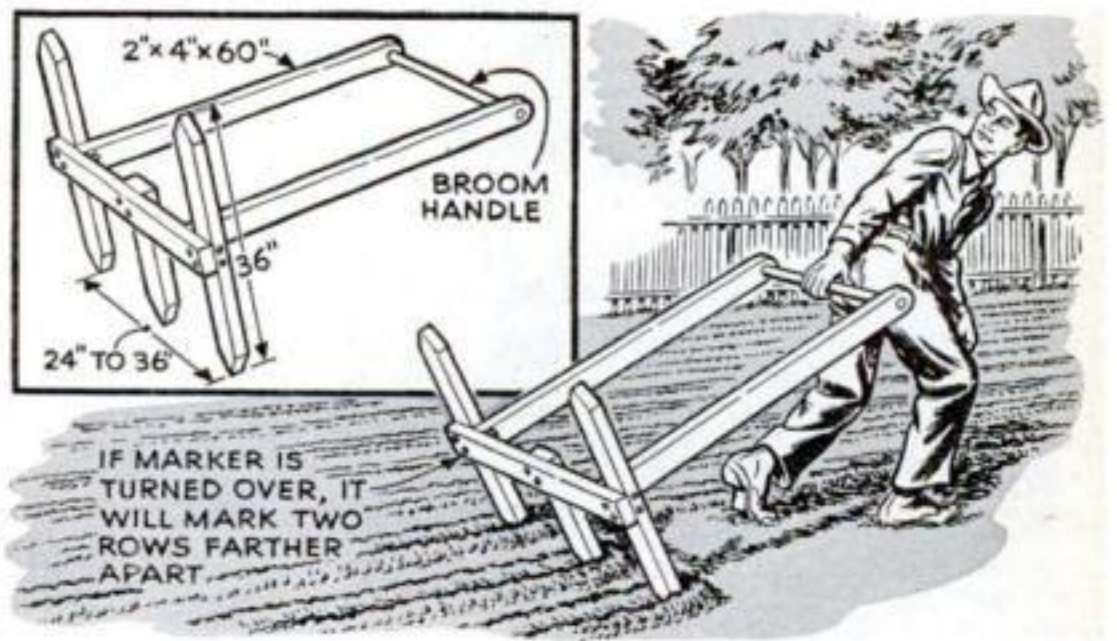
Heat the acid in the flask very gently, never allowing it to boil. Greenish chlorine gas soon pours into the test tube. Part reacts with the lime, while the remainder is carried into the sodium hydroxide solution below. After several minutes you get a calcium hypochlorite powder as effective as the household disinfectant and bleach.



ULTRAVIOLET RAYS reduce poultry mortality by as much as 68 percent, according to carefully controlled tests made at breeding farms by Dr. Harvey C. Rentschler, director of the Westinghouse Lamp Division Research Laboratories at Bloomfield, N. J. Lamps that generate these bactericidal rays are placed along the walls or ceilings of feeding houses and hatcheries to affect the greatest open area. Besides lessening the infectious organisms in the air, the lamps diminish fungus and mold producing mycosis and brooder pneumonia. Small, continuous amounts of Vitamin-D wave lengths radiated by these lamps proved as effective for promoting growth as the method of using short, high intensities.

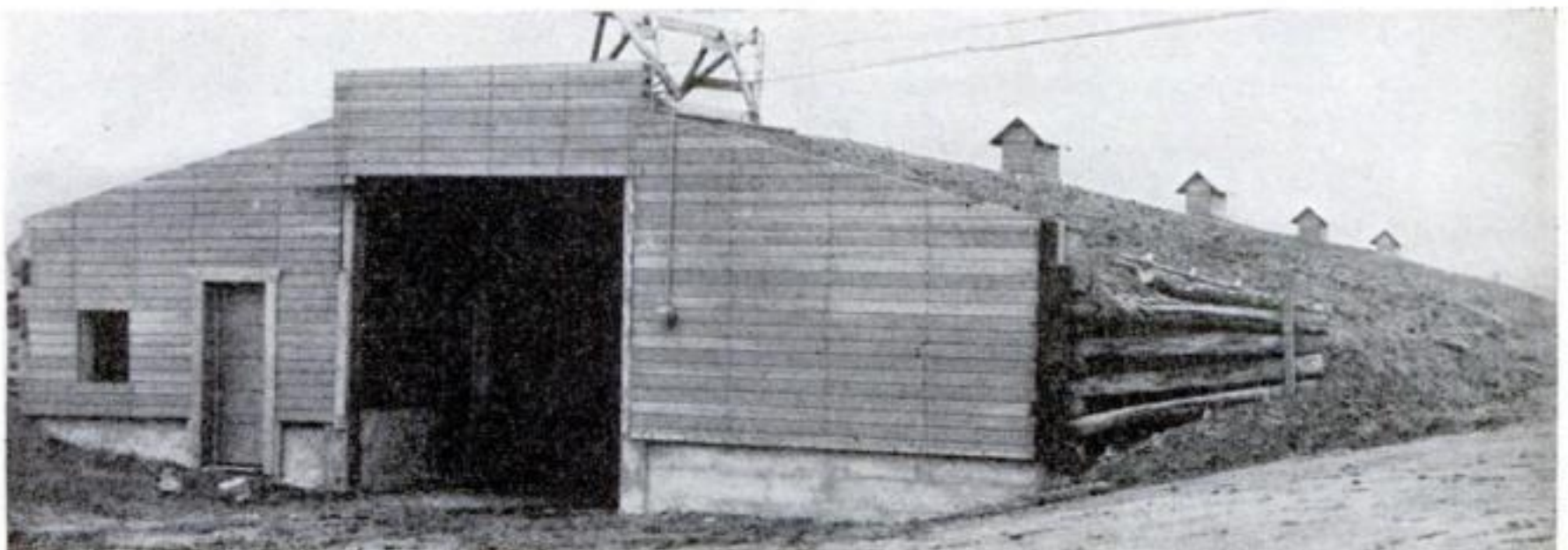
REVERSING THIS MARKER

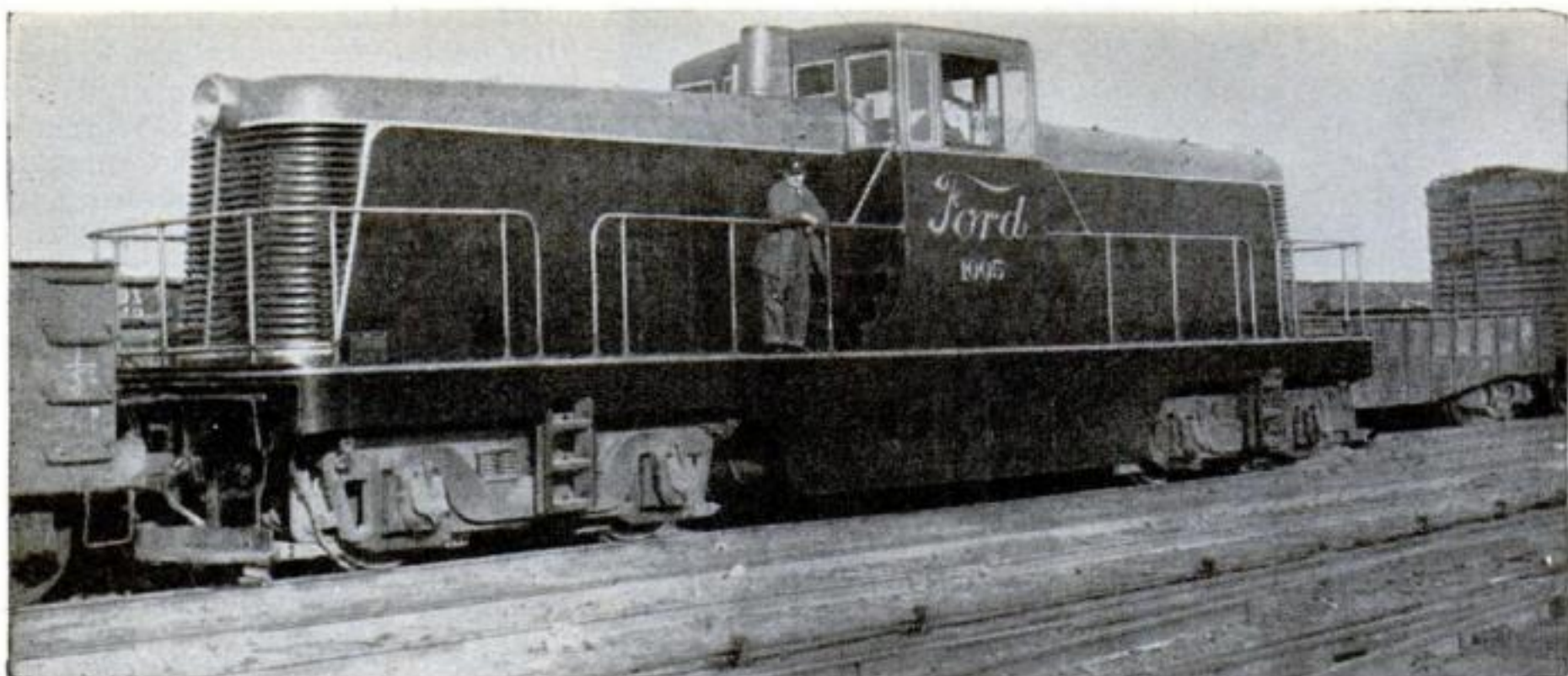
so that either two or three prongs scratch the soil makes it possible to mark narrow or wide furrows when setting out vegetables or other small plants. Fir or similar stock, 2" by 4", is suitable for the construction of the marker—made and used as shown at right—and has sufficient strength to mark the soil deeply. The cross bar by which the tool is pulled can be made from an old broom handle.—R. S. W.



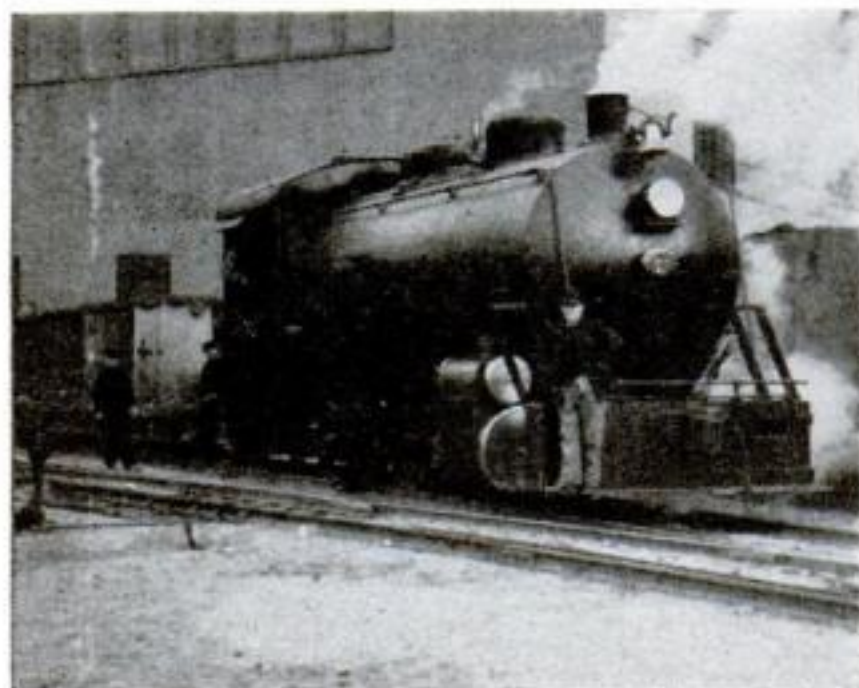
MASS POTATO STORAGE is being accomplished by an organization of young Utah farmers who designed and built one of the largest storage cellars in their state. The structure, 40' by 300', is wide enough for a truck to enter and unload. Lining it are 40 bins, each having a capacity for 500 sacks of spuds—a total of 20,000 sacks. Pine poles

were used for the supporting members and rafters, the latter being covered with ordinary willows cut from the river bottoms. On top of these was piled wheat straw to a depth of 3', and above this insulation 6" of dirt was spread and tamped down. Ventilators for the storage house were spaced along the roof.





Henry Ford's railroad for shuttling arriving and departing cars through the Rouge plant includes 100 miles of track and 21 locomotives, of which this 1,000-horsepower Cooper Bessemer is the largest



The "Fireless Cooker" is a locomotive without a fire-box. It is charged at an open-hearth steam line with 200 pounds of pressure to haul ingot molds

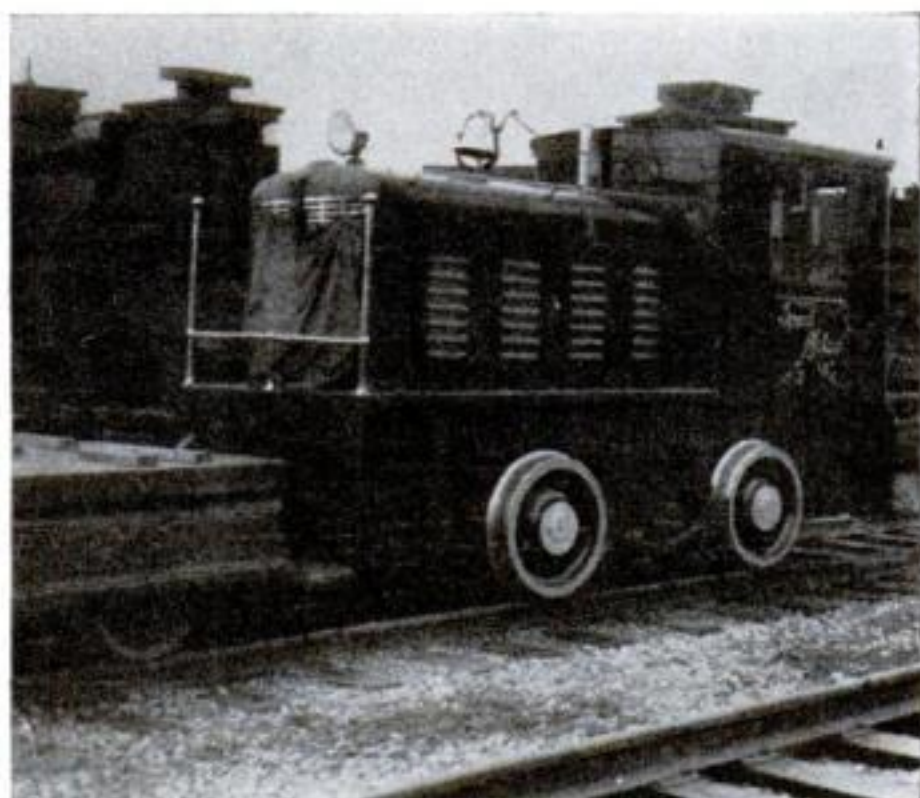


Rusted-out steel cars are rebuilt by the Rouge plant from the wheel trucks up. The plant also repairs the cars of other lines and services its own locomotives

"Tom Thumbs" are miniature Diesel locomotives used inside buildings and for pulling flat cars loaded with dies. The Rouge Railroad has 10 Diesels

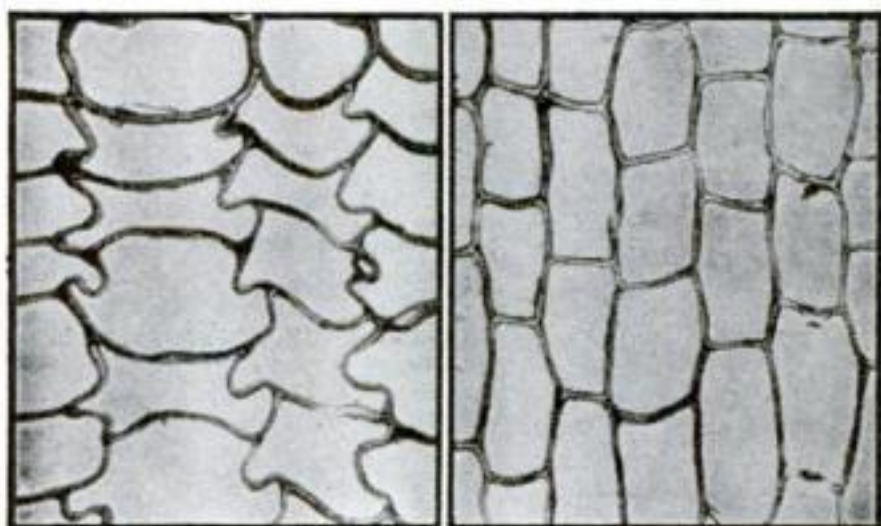
Henry Ford's Railroad

HENRY FORD is the owner and operator of a railroad. At the Ford Motor Company's Rouge plant, all the incoming and leaving cars are shuttled between points within the plant limits with Ford railroad equipment manned by more than 400 employees. Eleven of the 21 locomotives are powered by steam, while the other 10 are the Diesel-electric type. Besides the locomotives, there are hundreds of units of rolling stock, including steel hoppers, gondolas, flat cars, tanks, and dump cars. Plant shops rebuild the cars of the Rouge line and other roads, and service their own locomotives.



American Cork Is Made from Douglas Fir Bark

CORK found in the bark of Douglas fir trees will be used to compensate for the lack of imported cork. The first cork-producing plant is near Seattle, Wash., where the product will be made available for bottle-cap liners, life preservers, and insulating materials. Processing the cork for commercial use, developed from unpromising beginnings (P.S.M., Jan. '43, p. 110) by Bror L. Grondal, professor at the University of Washington, consists largely of steeping the raw cork in a weak ammonium hydroxide solution, washing and drying several times, grinding, and screening.



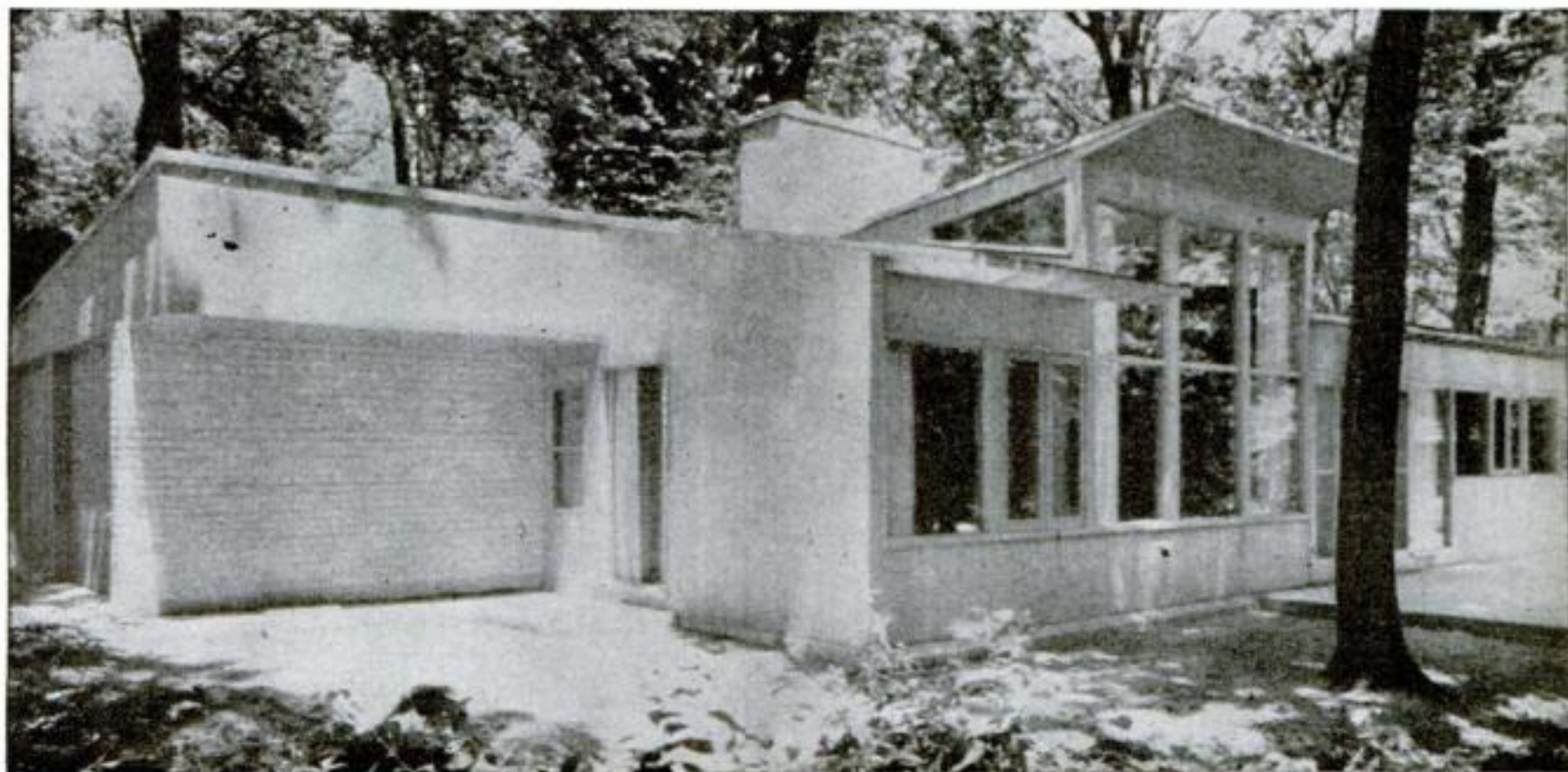
Prof. Bror L. Grondal, of the University of Washington's department of forest products, examines a sample of the cork that has been freshly ground

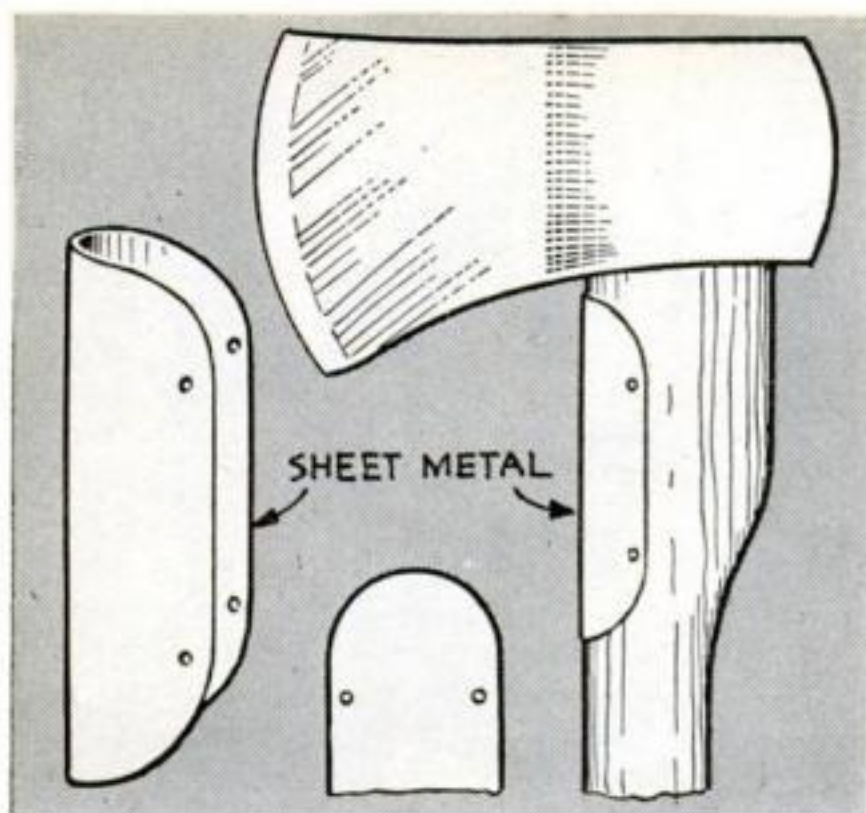
At near left is Mediterranean cork magnified 660 times. Shown at far left with the same magnification is American cork, its cells partially collapsed

Functional Dwellings Help Regulate Their Own Temperature

CONCEIVED and built by George F. Keck, Chicago architect, the house pictured below is one example of the patterns architecture may follow when buildings become purely functional. Features of these houses include flat roofs that carry a layer of running water for cooling, and overhangs

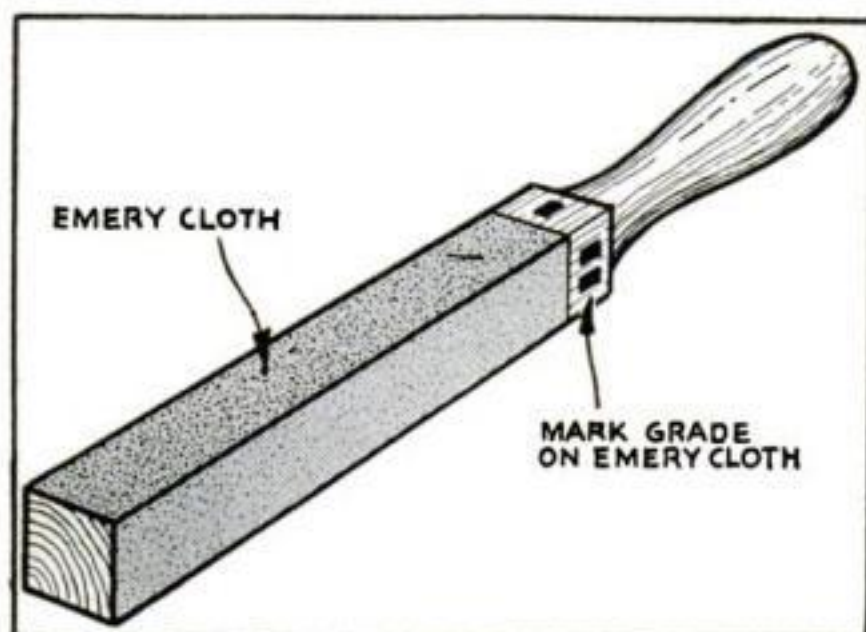
above the windows so placed that during midsummer the sun does not shine directly into the house, but in winter sends its warm rays in at nearly right angles. The orientation of the house is with reference to obtaining maximum advantage from both the light and heat of the sun.





Sheet-Metal Guard Prevents Damage to Ax Handle

DAMAGE to an ax handle, which is most likely to occur just behind the cutting edge of the head, can be prevented by a guard cut out of a piece of sheet metal to the shape shown in the drawing above. Punch four small nail holes near the edges, and then bend the piece almost double so it will fit the contour of the ax handle. The guard is then nailed in place on the handle with small brads.—JOHN A. DEHAAN.

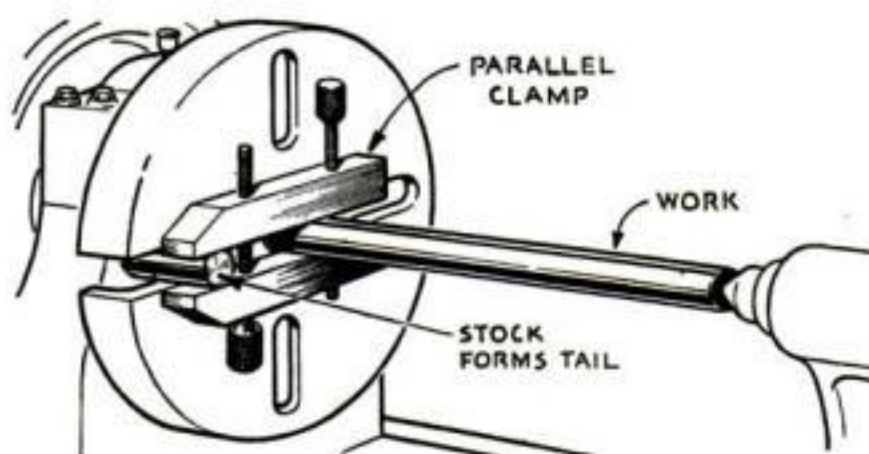


Convenient Emery "Stick" Has Four Grades of Abrasive

FOUR grades of emery cloth glued to a 12" piece of 1" by 1" wood stock will give you an emery "stick" that will be found useful in model making as well as in other small jobs in the home workshop. Whittle a handle on one end of the stock, and then glue the emery cloth to the four sides in 1" strips, marking the grade of each side near the handle. When a piece becomes badly worn, it can be removed by soaking in water if ordinary glue was used.—R. E.

Machinist's Parallel Clamp Serves as Lathe Dog

WHEN available lathe dogs will not fit a job in hand, an ordinary parallel clamp and a short piece of stock of the same diameter as the work can be used instead. Put the end of the workpiece near the faceplate between the arms of the clamp and between the screws, as shown in the drawing, slip the short piece of stock in the faceplate slot and also between the clamp arms, and tighten the clamp evenly on both pieces. If the diameter of the short piece is too large to go into the faceplate slot, an end must, of course, be turned down to fit before it can be used.—ROBERT H. DALTON.



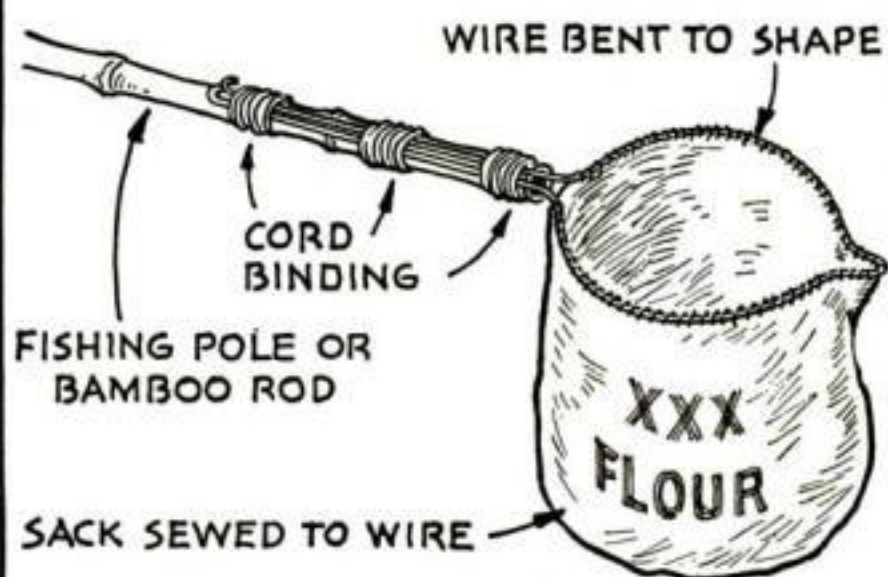
Simple Repair Mends Break in Pocket Steel Rules

WINDING steel rules that have broken off near the winding spring can be put back into service by a simple repair. Discard the short broken piece at the spring end; then square off the break on the long section by snapping it sharply with a pair of pliers, and make a new slot by bending the piece near the end and holding it to the edge of a grinding wheel. Keep the slot small or it won't engage the stud.

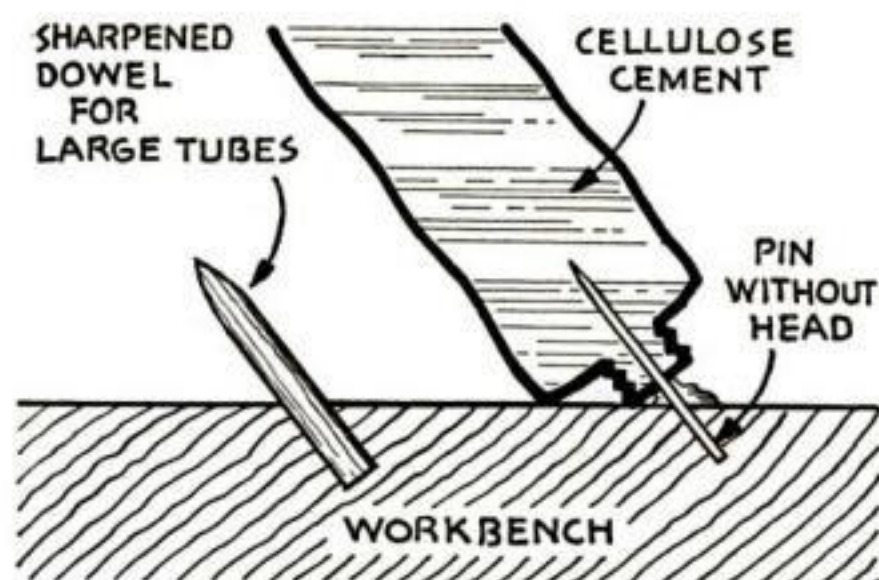


Wire Loop Forms Fruit Picker

APPLES, peaches, and other fruit can be picked easily from a tree where it grows out of reach when a simple device like that shown below is used. The picker consists of heavy wire bent to the shape shown and tied securely to a broomstick or pole. A 10-lb. flour or sugar sack sewed to the wire catches the fruit as it falls when the notch at the far end of the loop engages the stem and pressure is exerted. Several pieces can be caught in the sack without being bruised or injured.—I. H. WALBRIDGE.



Stoppers Fixed to Workbench Keep Model Cement Handy

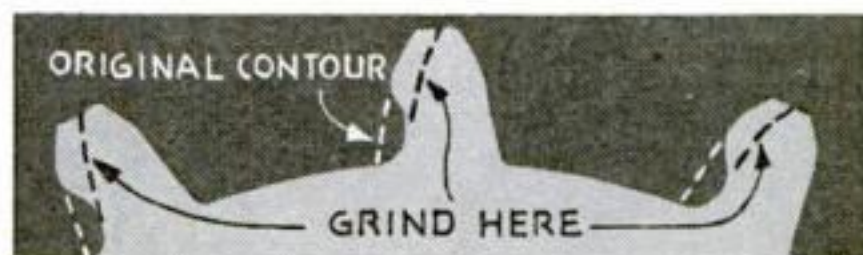


PINS and nails from which the heads have been removed can be driven at an angle in the bench to serve as stoppers and holders for tubes of model-making cement. They should be chosen in sizes to fit the opening of the tubes so as to provide a seal when the cement is not being used. Dowels of small diameter, glued into holes in the bench and sharpened at the top, may be used for tubes having large openings. Place the stopper-holders where they will keep often-needed tubes convenient.—MORTON LEWIS.



Lake Created in Living Room for Home-Movie Background

FRAGMENTS of thick glass—the thicker the better—immersed in a shallow pan of water will give you an interesting shimmering-lake background for home movies of your characters in summer or sports costumes. Simply direct a spotlight on the pan of water and glass fragments so it will be reflected on a white screen as indicated in the photo above. Arrange your characters so their action will take place in the foreground, and direct your camera to catch them against the shimmering reflection on the screen, making certain not to include any of the props within the camera range. This is a professional trick that gives the effect of real water in the projection.



Grinding Job Adds Extra Life to Worn Bicycle Sprocket

WHEN your bicycle begins to pedal hard because of wear on the sprocket teeth caused by the chain, you can put off installing a new sprocket for some time by grinding off the rough humps so that the chain will again act smoothly and quietly. If you have a small portable grinder or a flexible-shaft tool, the sprocket need not be removed from the bicycle while grinding the teeth to a free-running outline.—L. R. GERBER.

Where There's Smoke—

(Continued from page 91)

falling into enemy hands in case of strategic retreat.

Smoke was originally used primarily for defense, and it is still used for that purpose at times. Smoke pots or generators can blank out whole cities in a matter of minutes. And in moonlight, certain types of smoke create the illusion of water when seen from the air. Along the Mediterranean this fact was used a good many times to confuse the German bombers. One port was "smoked out" so effectively that from the air it seemed that there was a huge harbor where the city should have been. By laying a decoy smoke screen of different color some distance away, our chemical artists tricked enemy bombers into dumping all their bombs onto an uninhabited hillside. The ruse was so effective that one German bomber pilot, when shot down and captured, would hardly believe his eyes when he was shown the target city, untouched by bombs.

Our forces have used smoke in every landing operation, both in Europe and in the Pacific. Different terrain calls for different methods, but smoke screens can be laid by planes using either spray tanks or bombs, by PT boats dropping smoke pots, by mortars or other artillery, or by smoke pots

and generators on land. Smoke bombs dropped from the air can blank out particular areas, smother defensive fire, and still leave an objective open and unclouded for our attack. Such tactics have been used repeatedly against the Japs with good results.

Both experiments and experience have shown that hand weapons as well as anti-aircraft and artillery are almost useless when smoked over. In test firing it was found that marksmen under smoke made less than three percent of their possible hits on a known target. Marksmen firing into smoke at known targets, on the other hand, made 12 percent of possible hits. That clearly shows the advantage with the attackers when smoke is laid on an enemy stronghold.

Furthermore, experience has shown that white phosphorus, the best of all smoke producers, has vital antipersonnel action. In the Pacific particularly, a few white phosphorus bombs will clean out almost any Jap artillery installation long enough for effective ground action. The boys who have been there have no illusions. "Smoke 'em out with WP," they say, "and then things begin to happen. Chemical Warfare opens the door when the going gets tough."

200-Foot-Long Color Photos

(Continued from page 98)

although it may be somewhat distorted in dimension.

Everything is calculated in advance. The pilot carries with him a chart which is keyed to the focal length of his particular camera lens. It shows him at a glance the correct speed at which the film must move for a given altitude and air speed. He sets the variable speed mechanism of the camera accordingly. A special slide rule shows him the correct width of slit opening, as determined by these other factors. Now he is ready to make his run over the target. In practice, these photo pilots shoot lengths of film in bursts, starting and stopping the camera as they find the subjects they want to shoot.

They can use up a lot of film in a hurry on an actual mission, especially if they fly very low, for it is then that the film must be speeded up to the highest rate.

The low-flying reconnaissance flier depends entirely upon speed and skill to come through his dangerous missions alive. The fastest pursuit ships are used for this duty, and they are made even faster by stripping

them of guns and any other equipment that can be dispensed with. The photo pilot is not expected to fight. He is expected only to get in, get his pictures, and get out—fast. The extremely low altitude is a protection in that it helps him to approach his objective without very much danger of being detected at a distance.

Bad weather doesn't bother the strip camera much. Army pilots have taken clear pictures in a driving rain, flying at 300 miles an hour at a 100-foot altitude. The ability of these cameras to "stop" action is also rather remarkable. An action, for instance, that would require an exposure of 1/2,000 of a second for the conventional camera can be stopped by these cameras with an exposure of as much as 1/200 second.

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

W R I G H T P O W E R S T H E T O N N A G E O F T H E A I R

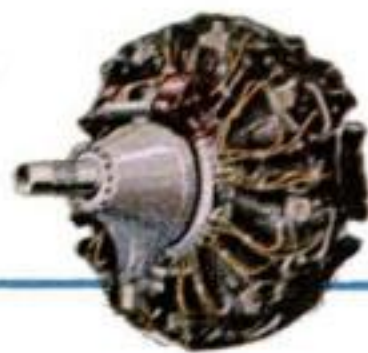


The real *payload* is the full load

Let's be realistic. Many have prophesied, ourselves included, the future vastness of air transportation. The industry well knows its great possibilities. But the most pressing problem in aviation will be to make sure that *all* transports, large and small, fly full.

The full transport is the key to expansion because it provides that margin of profit which makes possible reduced rates—and, in turn, more business. First class mail by air, the opening up of new cargo possibilities, the establishment of feeder service, faster schedules and more economical operation are goals which will provide increased public usefulness and acceptance. All are within reach and can be made actualities of the near future.

As an engine manufacturer, our contribution is operating economy. The aircraft designer can rely on Wright engines to operate on less fuel and cost less for maintenance. And because they weigh less than comparable powerplants, they provide a profitable payload bonus. *Wright Cyclones pay their way.*



Cyclones Save 3 Ways

LESS WEIGHT—MORE PAYLOAD
LOWER FUEL CONSUMPTION
REDUCED MAINTENANCE

WRIGHT
Aircraft Engines



Remember when...

Jack Rabbit starting was fashionable?

REMEMBER the private thrill of showing 'em the color of your exhaust smoke when the light flashed green?

The fact that such "jack rabbit" starts and sudden stops wore tires 3 times as fast as normal didn't seem important then.

Today it is important! The rubber crisis is *not* over. Reserves of natural rubber are dangerously low, and there are not nearly enough synthetic tires to go around. Your tires must *still* be conserved, cared for, made to last as long as possible.

Compared to the job American boys are doing across both oceans, it's no great sacrifice to give up "jack rabbit" starts and sudden stops. It's not difficult to avoid hitting curbs, bumps and ruts. Keeping tire pressure up to 32 pounds, and having small cuts and bruises repaired before they do real damage isn't

really much bother. And all it takes is a little will-power to keep your speed under 35.

Yet, there's scarcely any single war contribution you can make that is more important today than observing those simple tire-saving precautions! The Battle of Rubber and Transportation is NOT won. Do your part—let your independent tire dealer help you.

★ ★ ★

REMEMBER WHEN you were stranded out in the country with a flat and no spare? Remember the INDEPENDENT tire dealer who left his dinner table to fix it for you? Owning his own business gives a man a powerful incentive to provide better service and better values. That spirit of Independence has always created good living and good jobs that have made Americans the envy of the world . . . and Seiberling believes that it can keep on doing it. That's why in the future—as always in the past—Seiberling Tires will be sold by Independent Dealers only.

SEIBERLING Experts in Rubber



Wartime manufacturers of Bullet-Sealed Tubes and Military Tires for our armed forces • Bullet-Sealing Gasoline Tanks • Rubber Floats, Boats and Pontons • Rubber Parts for Gas Masks, Airplanes and Tanks. Also makers of Tires and Tubes for passenger cars and trucks • Sealed Air Tubes • Rubber Heels, Soles and Mechanical Goods.

In this process, he has taken over breweries, a tobacco factory, an airplane and a bomb factory, besides many others.

The Custodian's office also became the owner of all enemy-owned patents and applications for patents. These fruits of the enemy's research and inventive genius may possibly be more valuable to us than all the other property seized, if we make full use of them. They are offered for license to American citizens at \$15 each for the life of the patent, but nobody can obtain an exclusive license. It is the purpose of Custodian Crowley to see to it that all of these 45,000 inventions are made freely available to everybody. One purpose of this policy is also to prevent the enemy nations from regaining control of them again after the war, as happened in many cases after the last war. There will be few single ownerships under these conditions of license, and it will be difficult for anyone to obtain a monopoly.

About 2,000 of these patents and applications have been licensed to Americans, and there are nearly 10,000 applications for licenses now pending. Five libraries, open to the public, contain all of the patent papers and applications. They are in Washington, New York, Boston, Chicago, and Portland, Ore. There is a librarian in charge of each to assist interested persons in finding what they want.

Every classification of the Patent Office is represented in these foreign inventions. The largest list is under the heading of radiant energy, which includes radio, television, and electronics in general. There are nearly 2,000 foreign-owned patents or applications in this field, for the Germans especially have gone in strong for this line of research and invention. Government agencies, of course, have studied these and other classifications pretty thoroughly, but nobody believes this hunting job has been finished. Whether we have found out things from the enemy that we didn't already know is a question that is not being answered, for obvious reasons.

Persons living too far away to visit these libraries can start their research by sending to the Chicago office for lists of classifications. By succeeding steps they can learn the numbers of patents that interest them and obtain the copies from the Patent Office in Washington.

Everybody knows that the Germans have been especially aggressive in the chemical field. The fruits of their labors are contained in these patents. Some of these now

available to Americans at \$15 may have cost hundreds of thousands in research and experimentation. We know the Germans have been abreast of us in development of plastics, possibly ahead of us in some respects. There are over 700 plastics patents in this list, about 600 on photography.

We took over 200 patents belonging to Jasco, a subsidiary of the great I. G. Farben concern. Of these, 58 cover synthetic rubber. There are steel patents from Krupp, camera and optical patents from Zeiss-Ikon and Leitz, aircraft-instrument patents from Siemens, and so on.

We also took possession of all copyrights on books and music held by enemy nationals. Among these, the most important at present are German technical books, which are being reprinted by American publishers in order to disseminate the enemy's knowledge as widely as possible—to use their own brains against them in the war. A German encyclopedia of organic chemistry is being printed now by an American firm. This 59-volume work by Friedrich Konrad Beilstein cost \$2,000 when the Germans held the copyright. It is now sold for \$400.

Control of music copyrights has given the Custodian's staff many a headache. It became their duty to collect royalties on the publication and playing of countless pieces composed by foreigners. They are collecting regularly on "The Merry Widow," "Blossom Time," "My Man," "When Day is Done," and other works. This money is added to the big sum being piled up in the U. S. Treasury through the many activities of the Alien Property Custodian. What will be done with it remains to be decided after the war, and this is not the Custodian's responsibility. He has enough in administering and liquidating the multitude of foreign properties that have fallen into his hands.—
GOLD V. SANDERS.

To bring the date when **POPULAR SCIENCE MONTHLY** goes on sale closer to the date on the cover of the magazine, the August 1944 issue will be published on July 19 and the September issue on August 30. Thereafter, each issue will be published on or about the first of the month that is shown on the cover.

Subscribers will not lose by this adjustment of our publication date, as each will receive the full number of issues to which his subscription entitles him.

Millions of tons of America's food get to the stores and markets regularly because AC Spark Plug reliability keeps the trucks in service. Owners of those vital trucks save gasoline and lengthen the life of their spark plugs by having plugs cleaned and adjusted every 3,000 miles.



CLEAN PLUGS SAVE
UP TO ONE GALLON
OF GASOLINE IN TEN

AC
SPARK PLUGS

DO MORE THAN BEFORE — BUY WAR BONDS NOW

"I Like Destroyers"

(Continued from page 114)

quarters at night, and no one slept much. But no one complained. As destroyer men, they knew they were in the thick of things. That's a destroyer's mission in life. Besides, Navy men traditionally gripe only when they have time on their hands.

We drew our first blood while we were returning to base from a night sortie. A two-engine Jap bomber (we came to know the type as "Bettys"), apparently completing a dawn reconnaissance mission over Guadalcanal, crossed our course ahead. In a matter of seconds it was in flames. For its first kill, the *Radford's* main battery fired twice. The second time we scored a direct hit. The plane crashed. The gunnery officer and I picked up the pilot and his observer in a boat. Both were dead.

The squadron to which the *Radford* was attached kept a weather eye on the blue-green waters for a sight of the Tokyo Express, but we did more than prowl. The *Radford* helped clear the way for the Marines in the final phases of the conquest of Guadalcanal by shelling Japanese positions on reverse mountain slopes, inaccessible to the fire of land batteries. Again that demonstrates the versatility of the destroyer and the perfection to which bombardment of land objectives from the sea has been brought. In the Battle of Sicily, destroyers actually helped knock out moving German tanks.

It was at this period, too, that training was perfected for the bombardment of Munda airfield on New Georgia Island and the Vila Plantation on Kolombangara that included an airfield. The *Radford* shelled Munda once and Vila twice. Vila really was a staging point for the large Munda airfield.

In all these operations the crew was told in advance by the captain what the mission was. He supplied as much detail as it was practical to disclose. I noticed that the tension in the crew was high before the action began, but, once we were in it, everyone relaxed for the job at hand.

Then, one day, the *Radford* received word to join a task force under Admiral Ainsworth and proceed up "The Slot"—the neck of water between New Georgia and Santa Isabel. The Tokyo Express was abroad again. But we needed ammunition and fuel. We doubted whether we could get supplied in time to participate.

The crew fell to. It always did. This meant a chance to participate in a major engagement. Destroyer men love a fight.

(Continued on page 198)



It's called a G-E UVIARC!

ULTRAVIOLET ARC

... General Electric Research announces a potent new germ-killer to make the magic of ultraviolet energy available for a healthier postwar world ... to bring the germ-killing powers of sunlight indoors.

Short-wave ultraviolet energy from this 15-watt G-E Uviarc kills disease-producing germs wherever they can be reached. While the Uviarc looks much like the G-E Fluorescent lamp, its chief output is ultraviolet energy instead of light. Properly designed fixtures, correctly installed, are essential to avoid the direct exposure of eyes and skin of persons in the room.



This little General Electric Uviarc will kill the disease-producing germs in this jar of infected water in less than a minute. An 8-watt Uviarc will disinfect water at the rate of 100 gallons per hour. Such irradiation leaves no taste.



One 30-watt General Electric Uviarc will kill 90% of the disease-producing germs in 700 cubic feet of air in one minute. It will effectively disinfect air in a room 10x10x20 ft. every ten minutes. In larger rooms, such as this experimental schoolroom, more than one Uviarc is used.

BUY WAR BONDS AND HOLD THEM

General Electric makes the Uviarc but does not make fixtures for its use. For an illustrated folder giving further information write General Electric Co., Division 166-PSM-7, Nela Park, Cleveland 12, Ohio.



The General Electric Uviarc will be available for extensive use in approved equipment for disinfecting air as, for example, in cabinets for storing sterilized bottles and other equipment for babies.

GENERAL ELECTRIC

Hear the General Electric radio programs: "The G-E All-Girl Orchestra", Sunday 10 p. m. EWT, NBC; "The World Today" news, every weekday 6:45 p. m. EWT, CBS.

JULY, 1944

Buy War Savings Bonds and Stamps regularly.

197

GIVING A MACHINE THE BREATH OF LIFE



Photo courtesy
Fawick Airflex Co.



IN BUILDING precision machinery, it is usually the combination of trained mind, skilled hands and *right file* that provides the final assurance of good performance.

No single type of tool has yet been discovered which can be applied with greater versatility toward "making things work" than files. Their production is an "industrial art" which can well be a tool manufacturer's sole business.

For 80 years Nicholson has been making files and nothing else. Nicholson devotes its field studies wholly to files for industrial production, sharpening tools and implements, working different kinds of metals and other materials.

So, when you ask your hardware or mill-supply dealer for a file for a specific purpose, you can be sure that in Nicholson or Black Diamond brands you can obtain exactly *The right file for the job*—under the guarantee of *Twelve perfect files in every dozen*.

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(Also Canadian Plant, Port Hope, Ont.)

NICHOLSON
FILES FOR EVERY
PURPOSE



"I Like Destroyers"

(Continued from page 196)

I don't mean to say that the men of other types of warships don't love a fight, too. But destroyer crews spoil for a fight. The crew of another destroyer helped us get ready. Admiral Ainsworth meanwhile had canceled the order for us to join his forces. He didn't think we could make it.

As his force was steaming up The Slot, we joined it. Admiral Ainsworth signaled, "Glad to have you along." His destroyer screen, commanded by Captain McInerney, was rather meager.

At about 1 a.m. we made contact. There were, we believed, nine ships in the enemy force. They were leaving Kula Gulf, supposedly heading back for their base in Bougainville area.

Our cruisers opened fire. Our destroyers followed immediately. In the pitch blackness the enemy traded torpedo spreads with us. The gunfire on the *Radford* was so heavy that the white-yellowish mushrooms of fire at our gun muzzles blinded us to the enemy's counter fire. Enemy shells splashed around us. Several torpedo wakes were reported. It was easy to see them because the water in that area is phosphorescent.

Finally the *Helena* was hit. We didn't know it then. She showed no evidence of distress. There had been no explosion, no flame. The gallant cruiser kept firing. In fact, she went down with all her guns blazing. It was said that we sank five Japanese ships and that the *Helena* herself accounted for the one that mortally wounded her. We discovered the *Helena's* plight only after a prow was sighted, sticking up out of the water. Admiral Ainsworth dispatched the *Radford* to investigate.

"I am sorry to report," we signaled, "it is Five Zero."

The remainder of the enemy force had fled. But now we had a critical problem on our hands. In the water, heavily scummed with oil, floated hundreds of men, most of the *Helena's* complement. They had to be rescued if possible. The Japanese were known to have a force of planes in the Shortland area, a bare 60 miles from Kula Gulf.

The Admiral detailed the *Radford* to the rescue work, with another destroyer, the *Nicholas*, commanded by Commander A. J. Hill and with the squadron commander, Captain McInerney on board. The rest of his force he turned toward his base. We started our job.

It was slow, painstaking labor. In ones,

(Continued on page 200)

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your car



TUNE IN: FRED ALLEN every Sunday night.
See your local newspaper for time and station.

JULY, 1944

Buy War Savings Bonds and Stamps regularly.

199

TODAY...AND IN THE DAYS TO COME



Out of the war's testing cauldron has come no finer life saving device than the Switlik, American-designed and thoroughly proven **SAFE-T-CHUTE**. ☆ ☆ ☆ ☆ Born of the many years of practical experience to Stanley Switlik and developed to its present high standards through the genius of Switlik Engineers, there can be no better testimony to the efficiency of **SAFE-T-CHUTE** than the praise of the famous Caterpillars, that group of airmen who have bailed out but who go back "upstairs" with confidence, because of their faith in their **SAFE-T-CHUTE**. ☆ And when the war is won, rest assured that Switlik resources will be ready for other needs. Just as our output today goes to meet War's demands so will the Switlik Safety Products tomorrow play an important part in keeping the peace. ☆ ☆ ☆ Wear a **SAFE-T-CHUTE** whenever you take to the air. It is truly the "Lifeline of the Skies." ☆ ☆ ☆ ☆ ☆ ☆ ☆

NEW educational air-safety film available for colleges—training schools—high schools. ☆ ☆

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SWITLIK PARACHUTE COMPANY

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One million hours closer to Victory.

"I Like Destroyers"

(Continued from page 198)

twos, and small groups we pulled the *Helena's* oil-sodden men from the sea. Now the same man who had given us trouble during the *Radford's* shakedown operations and had drawn a BCD popped into the picture again. He already had become an expert gunner, drawing from the captain a recommendation that he be put on probation. Here he justified the captain's confidence in him. As coxswain of the captain's gig, he repeatedly towed life rafts full of survivors to the *Radford's* cargo nets flung overside for boarding. He stayed on the scene after dawn had forced the destroyers to leave, helping men ashore. I am happy to say that he himself later was rescued from New Georgia Island.

Three times enemy ships darting out of Kula Gulf interrupted our operations, and three times we had to trade gunfire with them. The last time we were up against tough opposition. A Japanese cruiser and two destroyers swept out boldly to finish us off. Our choice was quick. The *Radford* and the *Nicholas* engaged them. Struck squarely, the cruiser upended and sank. One of the destroyers possibly was sunk. One was damaged.

The morale of the men in the water was magnificent. It was matched only by that of the men who already had been rescued. When general quarters sounded at the appearance of the Japanese warships, the *Helena's* men on the *Radford* fell to. They went to the magazines and handling rooms. The ammunition was fed to our guns so fast that on the way back to base the *Nicholas* messaged us: "Where did you get your five-inch machine guns?"

The survivors still in the water kept their heads. To help the rescuers find them, they co-ordinated their yelling or singing. One sailor was sighted swimming. Through a megaphone he was told to swim toward the *Radford* and he would be picked up.

"Are you going to 'Frisco?" he called back. "If you're not, I'll wait for the next destroyer."

The gunnery officer of the *Helena* remarked as he was being taken aboard, spewing oil, "This is the nastiest ocean I've ever been in." The *Helena* was the second ship that had been shot from under him.

Some 700 men were pulled from the water by the *Radford* and the *Nicholas*. Then we had to leave. It had been nerve-racking work, with those Jap planes just over the horizon. It wasn't until several hours after

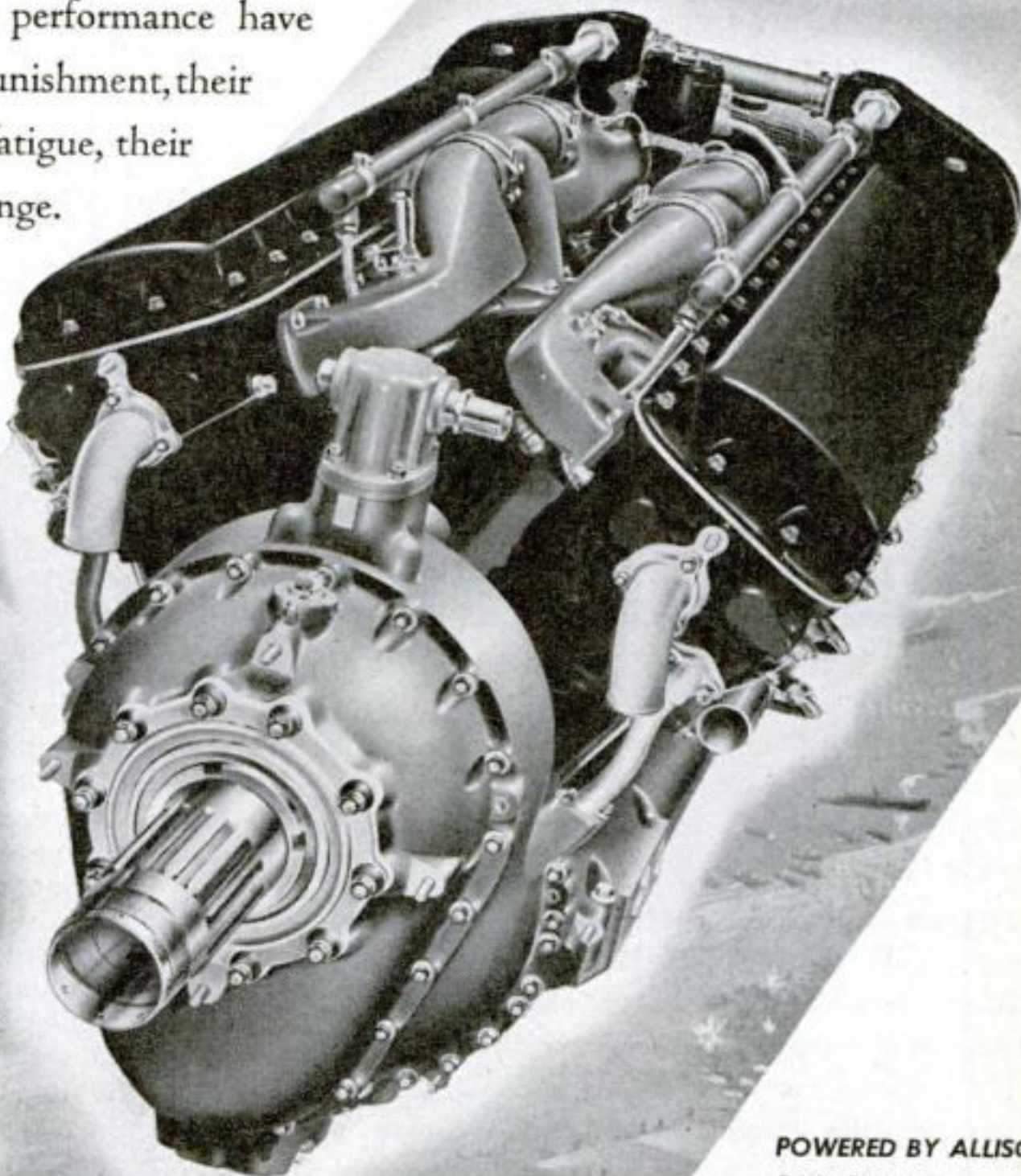
(Continued on page 202)

WORTHY WEAPON

America's fighter pilots using Allison-powered planes are downing the enemy on every battle front. ★

Allison engines by superb performance have proved their ability to take punishment, their smoothness to lessen pilot fatigue, their economy to provide long range.

★ These engines—worthy weapons today—will contribute to the comfort and safety of the planes you will ride in tomorrow.



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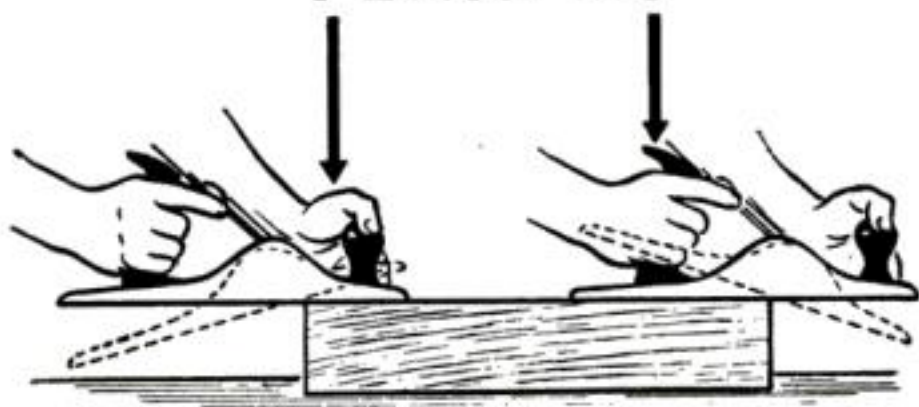
JULY, 1944

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Tool Tips by STANLEY

HAND PLANING



To cut a long, straight edge or surface, push the plane *with the grain* — in the uphill direction of the fibres. *Keep the plane straight* by pressing down on the knob at beginning of stroke and on handle at end of stroke.

It is easier to plane a long straight edge with a long plane than a short one. A long plane bridges the low parts and does not cut them till the high spots are removed.

DOZENS OF PROVED METHODS ARE COVERED IN THE STANLEY TOOL GUIDE

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"I Like Destroyers"

(Continued from page 200)

we were under way that fighter protection arrived.

As we steamed into port, the crews of the other ships in the task force were topside, lining the rails. Cheering is forbidden by naval custom; but they cheered. That welcome, from men who had gone through the battle with us, meant more than any decoration that could be bestowed on us. There was a lot of nose-blowing among the crews of the *Radford* and the *Nicholas*. Things like that give you a funny feeling in your throat. The next day one of the *Helena's* tough Marine Corps top sergeants came aboard to pay his respects to the captain and thank him for the rescues. He must have been peeling onions.

That day, too, I noticed something peculiar about the *Radford's* bulkheads. On one side of the vessel they were smeared with oil. On the other side they were clean. The explanation finally dawned on me. Those survivors who had not been passing ammunition for the actions that interrupted our rescue work had huddled against the bulkheads on the one side.

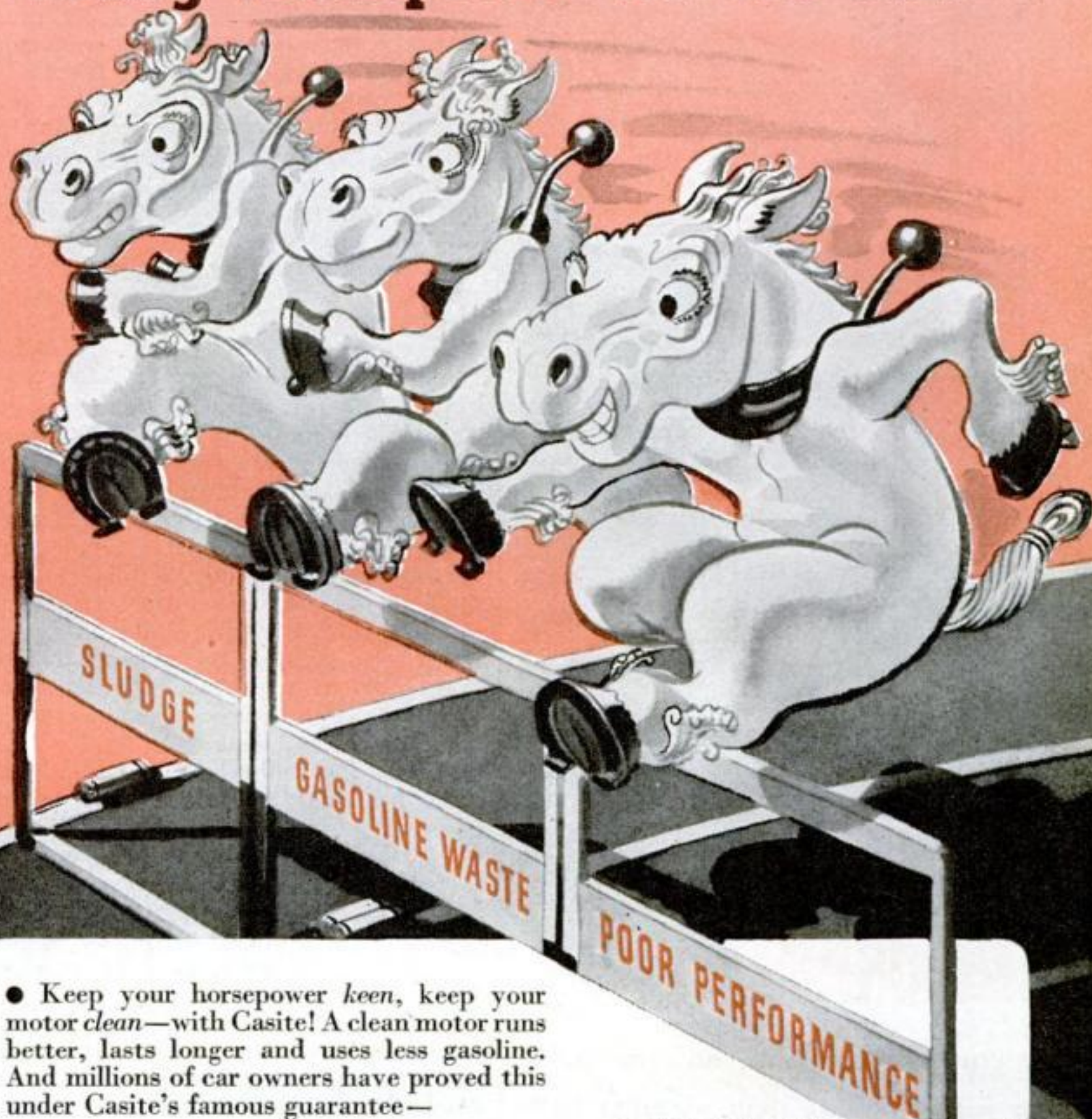
The *Radford* participated in the initial landing on Rendova Island, when the transport *McCauley* was torpedoed, and receipted for heavy air attack. It also helped escort the initial landing at Rice Anchorage, deep in Kula Gulf. It was quite a show. We were shelled heavily from two beaches. One of the ships in our destroyer squadron, the *Strong*, was sunk. In the midst of the action, word came from the radio shack that the condition was "red" on Guadalcanal—the island was under air attack. I couldn't resist the temptation to send back word that the condition was somewhat pink in Kula Gulf.

The day came when Captain Romoser was called to other duties. Of course I hoped to "fleet up"—to take command of the sturdy destroyer. It was with mixed feelings that I learned I was to be detached. Then, suddenly, I was given command of a destroyer as much like the *Radford* as another pea in a pod. It happened that she had not had an opportunity to see action under her captain, Commander (now Captain) T. C. Ragan. She was a splendidly organized ship and ready for her baptism of fire. She got it.

She was assigned immediately to front-line forces, and, as luck would have it, the squadron to which she was attached relieved the one that the *Radford* belonged to.

(Continued on page 204)

Young Horsepower for old cars



● Keep your horsepower *keen*, keep your motor *clean*—with Casite! A clean motor runs better, lasts longer and uses less gasoline. And millions of car owners have proved this under Casite's famous guarantee—

BETTER AND SMOOTHER PERFORMANCE OR DOUBLE YOUR MONEY BACK

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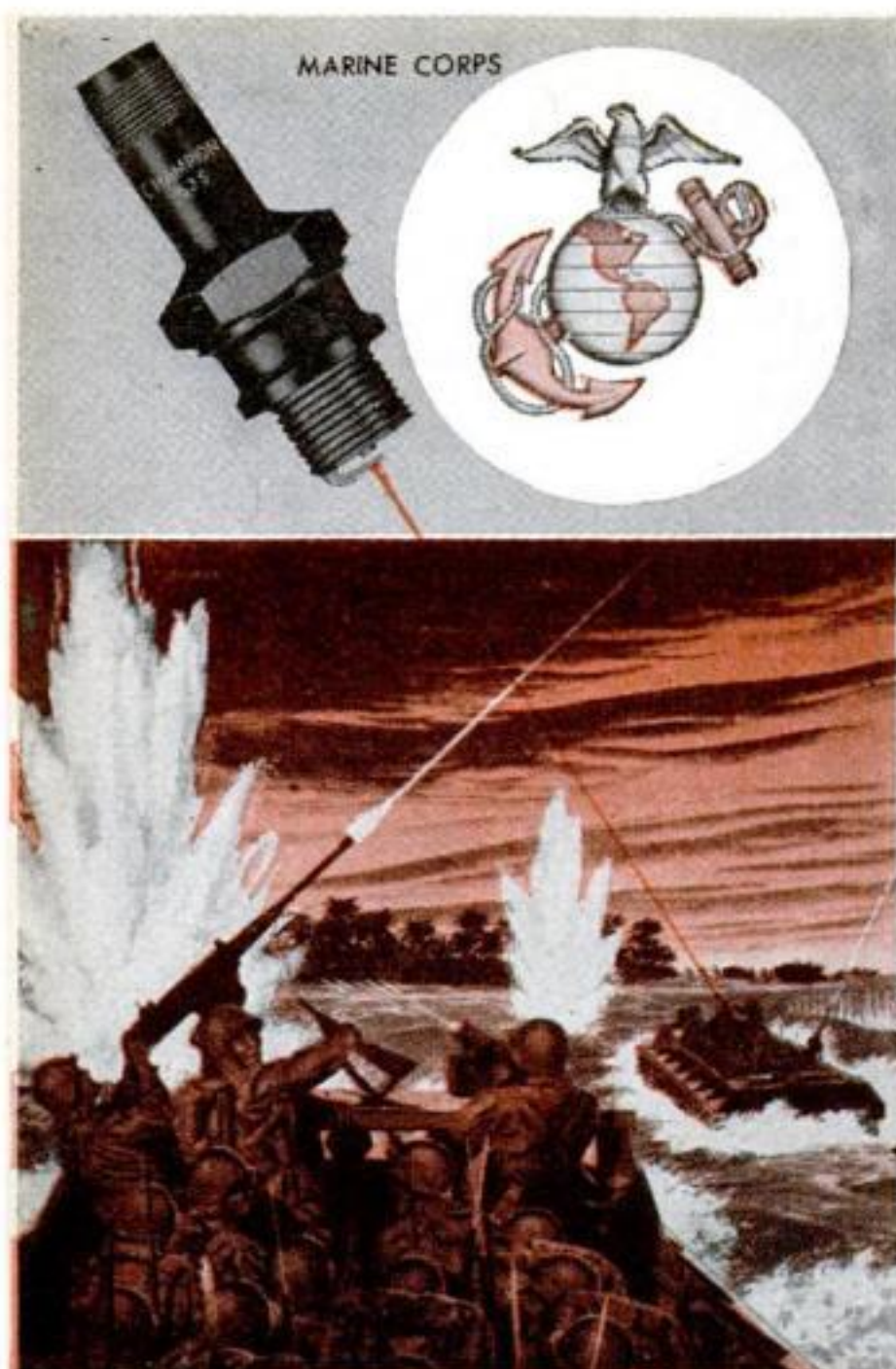
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LET'S ALL BACK THE ATTACK—BUY WAR BONDS

"I Like Destroyers"

(Continued from page 202)


The men were restless. They wanted action. They were typical destroyer men.

The crew learned what it meant, soon enough, to be under the constant attack, day and night, of Japanese airplanes. Ordered to help cover the landing on Vella Lavella, an island north of Kolombangara, we fought off dive bombers in the daytime and torpedo bombers at night. That went on not only during the initial landing, but also during the subsequent reinforcement operations. One dive bomber lifted our stern out of the water.

In helping cover the initial landing on Treasury Island, which was a step toward the further investment of Bougainville, we underwent an air attack by 100 Jap horizontal and dive bombers. While on the *Radford*, I had watched a whole squadron of Japanese twin-engine torpedo bombers burn on the water as they tried to press home a suicide attack, but this was something else again. So were the incessant "snooper" attacks by Japanese airplanes during the night as we escorted supplies to Treasury Island and later to Torokina, the beachhead established on Bougainville.

Before I left my command—reluctantly, I assure you—our destroyer had participated in several bombardments in different sectors of the North Solomons. Such bombardment actions seem to be marked by a phenomenon peculiar to the air spotting of fire results. If we were over or short, the pilot in the airplane cruising over the target would correct our range. However, if we were on target, the only way we knew we had the range would be unprintable ejaculations over the radio.

"Wow," the pilot would say, "look at those blankety-blanks run!"



Model Builders Attention!

	V	V-2	V-3
Hex	1/2"	3/8"	5/16"
Thread	3/8"-24	1/4"-32	1/4"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3 1/2	2 1/2

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205



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Atlas 4 TOOL TEAM for SMALL PARTS MACHINING



DRILL PRESSES



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MACHINES



SHAPERS



LATHES

America's "Secret Weapons"

(Continued from page 60)

have been hastily improvised, and the variety and sizes of carriages used indicate that their plans for these weapons were not well worked out.

At Aberdeen we have more than 4,000 tons of enemy equipment. Our men defied mines, booby traps, and strafing to capture it intact; big guns have been seized while still hot from firing. When this enemy ordnance is submitted to the same test as ours on the proving ground, much of it fails to stand up.

Examination of Japanese Army equipment has convinced us that the Japs do not belong in the "big league." They are not strong in automotive engineering, they are poor artillerymen, and the weapons that they specifically designed for jungle fighting lack firepower. The quality margin between our weapons and Japan's will increase as the war progresses.

It is already considerable. When our men landed on Attu, the Japs waited for them to shoot first, thinking that they must reload. The Japs would then carelessly expose themselves only to be picked off by the second shot of the quick-firing Garand automatic loader.

Japan made the mistake of arming her infantrymen with a .25 caliber rifle. It proved inadequate against our infantry's arms. At Tarawa, we found the Japs using a new rifle of .303 caliber. Thus they admitted a major error in the caliber of their basic weapon. If we were forced to change the caliber of ammunition of so vital a weapon, we would consider it a very serious matter, for there would be far-reaching consequences in production, distribution, supply, and maintenance.

German ordnance reflects years of preparation for war, and is the best we are up against. The more we study the details of German equipment, the clearer it becomes that this war was planned long before Hitler, even before the ink was dry on the Versailles Treaty. I visited Germany in 1922 and at their proving ground at Kummersdorf saw several of the new types of artillery weapons under test, in violation of the treaty.

The Germans attained a good degree of standardization. They reduced the number of component parts and made many of them interchangeable. Thus they have been able to supply and maintain a great number of weapons on the battlefield without waste of manpower.

(Continued on page 208)

SCREWBALL IDEAS ON BATTERY CARE

4

WATER
WATER



Bath tub brewers have the bright idea that since water weakens strong liquor and robs it of its kick, it will do the same thing to electrolyte, thereby weakening the power of the battery. They say not to add water, but don't believe it. A battery needs special care.

...THE WISE WAY IS PERIODIC RECHARGES!

KEEP your battery in tip-top shape by letting an experienced Exide Dealer check your battery regularly.

Restricted driving is hard on batteries. Rationed mileage keeps them from getting a normal charge from the generator, and can cause starting trouble unless certain precautions are taken.

In many cases, periodic recharges are essential, and with them, your Exide Dealer puts off the day when you'll need a new battery. When you *must* buy, get a dependable, long-lasting Exide. Buy to Last—Save to Win.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

EXIDES ARE USED IN MORE THAN 100
APPLICATIONS BY OUR ARMED FORCES



- 1 Don't buy *anything* you can do without.
- 2 If you **MUST** buy, insist on dependable, long-lasting merchandise.
- 3 Take care of the things you have. Make them *last*.

"BUY MORE THAN BEFORE
IN THE 5TH WAR LOAN."





"Good tools, like this Disston saw, are mighty hard to get these days, except for essential wartime uses.

"I couldn't get a new one, so I took this old rip-saw to my Disston hardware dealer for sharpening and repair. He did a swell job on it and now it cuts as good as ever."

That's a smart idea these days. Patriotic, too! Good tools are too precious to waste in wartime. Especially a Disston saw, made to give you *extra long service!* Your Disston hardware dealer can recondition any high-quality saw — and tell you about the possibility of securing new tools for *essential* service.



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CONSERVE ALL TOOLS UNTIL VICTORY IS WON!

The Disston Saw, Tool and File Manual shows you the right way to use and care for tools. **FREE** at your hardware store, or write us for your copy.



America's "Secret Weapons"

(Continued from page 206)

Furthermore, it seems that they watched us closely. When I was in Germany, I saw carefully marked copies of *Army Ordnance* and other American publications stacked up in the offices of their manufacturers. And they still are trying to catch up with our developments. They have attempted recently, for instance, to produce a rifle comparable to our Garand, but have only partially succeeded.

Their industrialists never became as proficient as ours in mass production. Their manufacturers were so hemmed in by tariffs that their peacetime markets were too limited for thorough application of mass-production principles. Their factories filled great depots with ordnance that was as modern as any before the war, but much of that equipment now appears obsolescent when placed alongside our further-developed ordnance. The Germans made the fatal mistake of underestimating the engineering flexibility of the United States.

As our bombing of their factories has hampered their production of new weapons, the Germans have resorted more and more to substitutions and improvisations. They have put guns, for instance, on carriages that were not intended for those guns. Thus they have made use of equipment produced in the conquered countries. But makeshift weapons break down more often than those that are well designed and built, replacements and repairs of ordnance that is not standardized become increasingly difficult, and the differences between their weapons and ours become more pronounced.

Napoleon is supposed to have said that "God is on the side of the battalions with the bigger cannon." Whether "bigger" refers to caliber, range, rapidity of fire, mobility, durability, or any other characteristic, the advantage appears to be increasingly ours—thanks to the years of hard work between wars by our ordnance officers, the progress of science, and the flexibility, amazing productive capacity, and all-out efforts of American industry.

Super-Duper Bus Design

THE idea and comprehensive design for the "postwar super-duper bus" pictured and described on page 88 of the June issue of *POPULAR SCIENCE MONTHLY* should have been credited to the humorously imaginative engineers of the J. G. Brill Company, of Philadelphia, Pa., builders of the a.c.f. motor coaches.

WHERE ARE THEY NOW?

This is an Elastic Stop Nut.

There are more of them on America's planes, tanks, guns, and naval vessels than all other self-locking nuts combined.

The reason is an Elastic Stop Nut holds fast and locks tight without any extra locking gadgets.

It does this because of the elastic collar in the top.

This collar squeezes between the bolt threads. It grips both sides of the threads. So no amount of vibration shakes the nut loose.

You can take the nut off and put it back on, time and time again, and it still retains its locking effectiveness. This is because the collar is elastic and "comes back."

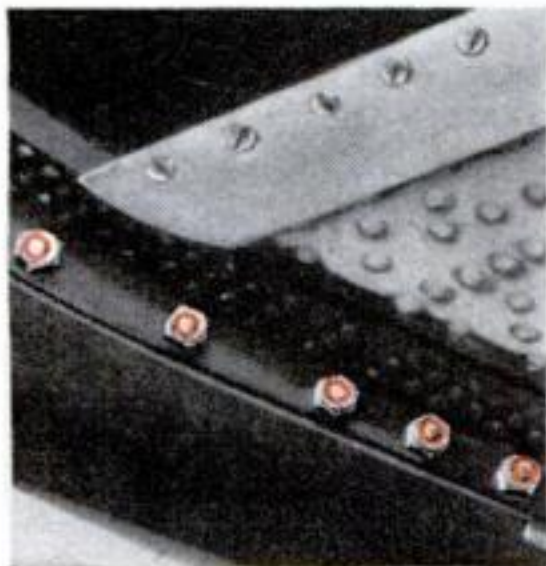
Billions of Elastic Stop Nuts are in use. And as far as we know, not one in a million has ever failed.

After a while, with the war won, you will be able to have these nuts with the characteristic red collar of ESNA on all the new equipment that will come. They will make it stronger, safer and more dependable just as they are doing on America's war goods today.



THE KIND OF JOB ELASTIC STOP NUTS ARE DOING

This is how the wing of a DC-3 transport plane is fastened on—with Elastic Stop Nuts, the nuts with the red collar so familiar to the aircraft industry. The tons of plane, crew and pay load depend on these nuts for their security. All told, this type of plane uses as many as 35,000 Elastic Stop Nuts.



ESNA

TRADE MARK OF

ELASTIC STOP NUT CORPORATION OF AMERICA

ELASTIC STOP NUTS

Lock fast to make things last

Union, New Jersey and Lincoln, Nebraska

MILLERS FALLS TOOLS

SINCE
1868

TOOL MAKER for the TOOL-MINDED

It's an American trait that is helping to win the war . . . this being tool-minded. Even though we may not make our living at it, most Americans know how to handle tools . . . and demand good tools.

Tops in tool making for a tool-minded nation is Millers Falls. That familiar trademark is a guarantee of dependability, durability and precision.

Millers Falls-quality line includes planes, hack saws, braces, auger bits, precision instruments, electric drills, hammers, nut runners, sanders, screw drivers and grinders — everything for discriminating craftsmen.

FOR EXAMPLE: PLANES

Ten sizes — lengths from 7" to 24" — comprise the standard Millers Falls line of bench planes. Each serves a separate purpose: short models for finishing broad, flat surfaces, reaching into the low spots; jack, fore and jointer models are progressively longer, for increasing degrees of straight, smooth cutting. Three exclusive features: three-point bearing lever cap, solid tool steel cutter, perfect fitting cutter cap

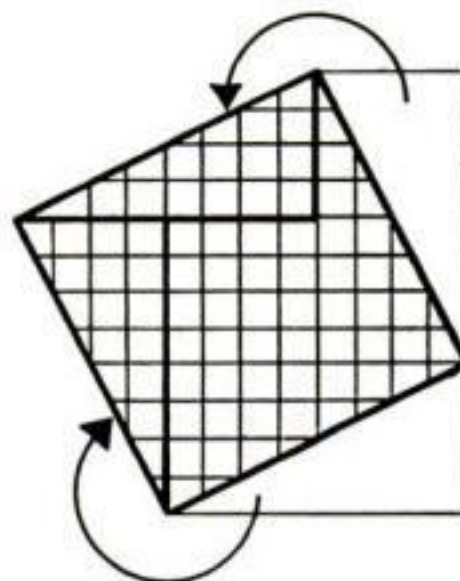


MILLERS FALLS
COMPANY

Greenfield, Mass.
U. S. A.

Answers to the Teasers

(Continued from page 62)



1 Cutting the cloth on the bias (why not?) gives the result shown. Perhaps Grandma used her woman's intuition, but any amateur mathematician can figure out where to make the cuts. His first question: "What will be the size of the finished square?" Inspection shows that the piece of cloth contains two squares, one of them 4 units and the other 8 units on a side. Since no cloth is wasted, the area of the final square will be the sum of the two smaller areas, 4 squared plus 8 squared, or 80 square units. The length of its side will be the square root of 80, which, as its derivation suggests—remember the Pythagorean theorem you learned in school?—equals the hypotenuse of a 4-by-8 triangle. Given this helpful clue, a few trials show where to cut off the triangles and put them back.

If you have a bent for making up puzzles yourself, many variations of this one can be constructed, with all shades of difficulty.

805	
746	310 x 4 = 1240
392	97 x 2 = 194
1	85 x 6 = 510
1944	1944

2a The solution given is one of many. As to method, tentatively arrange digits so that a 1 will appear in the thousands of the sum. Then select digits for the units column that will add up to a number ending in 4. Finally, shift about the numerals in the columns of tens and hundreds until their combined total puts a 9 in the hundreds digit of the sum. When everything is now

(Continued on page 212)

*There's
been a
big change*



PLUS-FOURS once brought in the low scores. And long skirts were the only acceptable dress. But all things change.

Even roller bearings have advanced. Tyson's new "All-Rolls" design is recognized as a vast improvement by users of heavy-duty equipment.

Size for size, Tyson has *thirty percent more load-carrying rollers*—for greater strength and rigidity . . . for longer life . . . for maximum efficiency.

In Army and Navy equipment—in vital industry, transportation, agriculture—the big name in bearings today is . . . **TYSON!**



TYSON BEARING CORPORATION, MASSILLON, OHIO

COUNT THE ROLLS - THE ROLLS COUNT



Tyson
TODAY'S HEAVY-DUTY BEARING

★ **BUY MORE WAR BONDS** ★

JULY, 1944

Buy War Savings Bonds and Stamps regularly.

211



Is it Loose?

Fix them with

SMOOTH-ON

The Handy Iron Cement

No home is ever without some little repair waiting to be made—yet needing only a few minutes time and a little Smooth-On No. 1 to remedy. And no home should ever be without a can of Smooth-On, obtainable at any hardware store. Furthermore, every home should *surely* have the **FREE** 40-page Smooth-On Repair Handbook, that shows so simply and clearly how to stop leaks, tighten joints, seal cracks, make innumerable repairs with this indispensable easy-to-use iron cement. Steam and hot water pipes, boilers,



Buy Smooth-On in 3/4-oz., 7-oz., or 1 larger cans from your hardware store or if necessary from us.

and hot water pipes, boilers, furnaces, radiators, auto crank and gear cases; loose screws, bolts, handles, casters, pulls, fixtures — all repaired effectively, quickly, inexpensively. No heat required, no previous experience.

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40 pages of instructions, suggestions, short cuts, 170 diagrams. Pocket size. Indexed for quick reference. Send for your copy now.

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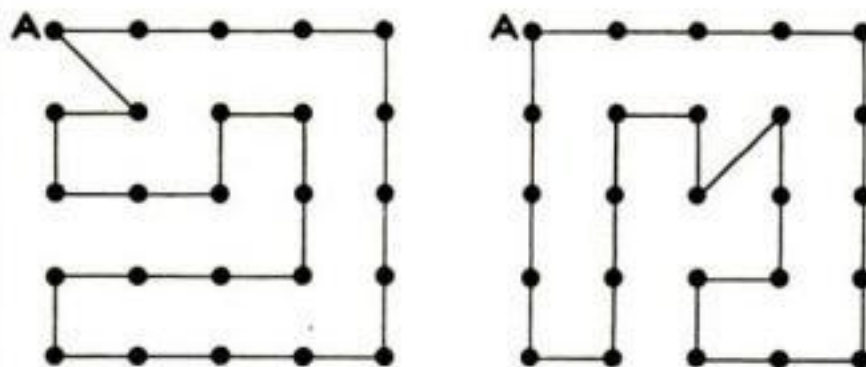
Do it with **SMOOTH-ON**

Answers to the Teasers

(Continued from page 210)

added, a 4 will automatically fall into the tens, and the desired sum of 1944 will result.

2b Harder than 2a, this number problem requires considerably more trial and error. Again, many solutions are possible. To obtain the one shown, a math shark first aimed for about two-thirds of 1944, tentatively choosing 301×4 . With the remaining digits, he tried for products adding up to about 700 and yielding a total which differs from 1944 by a multiple of 9. He selected 97×2 , and 85×6 , being prepared to change them if necessary. Adding all the products, he came out with 1908, falling short of 1944 by 36. Before starting over, he noticed that he could extricate himself from difficulty by changing the 301 in the first line to 310. This added just the required 36 to the product and the resulting sum, giving 1944.



3 Two of a number of possible solutions are illustrated. Try as you will, it is impossible to make the shortest tour without that curious little diagonal jog at some point along the way. Counting the distance between A and the nearest dot as one unit, the whole circuit requires a minimum of 24 horizontal and vertical moves, plus the jog. This adds up to approximately 25.414 units. A path using a longer diagonal, or one that crisscrosses, is bound to cover more distance.

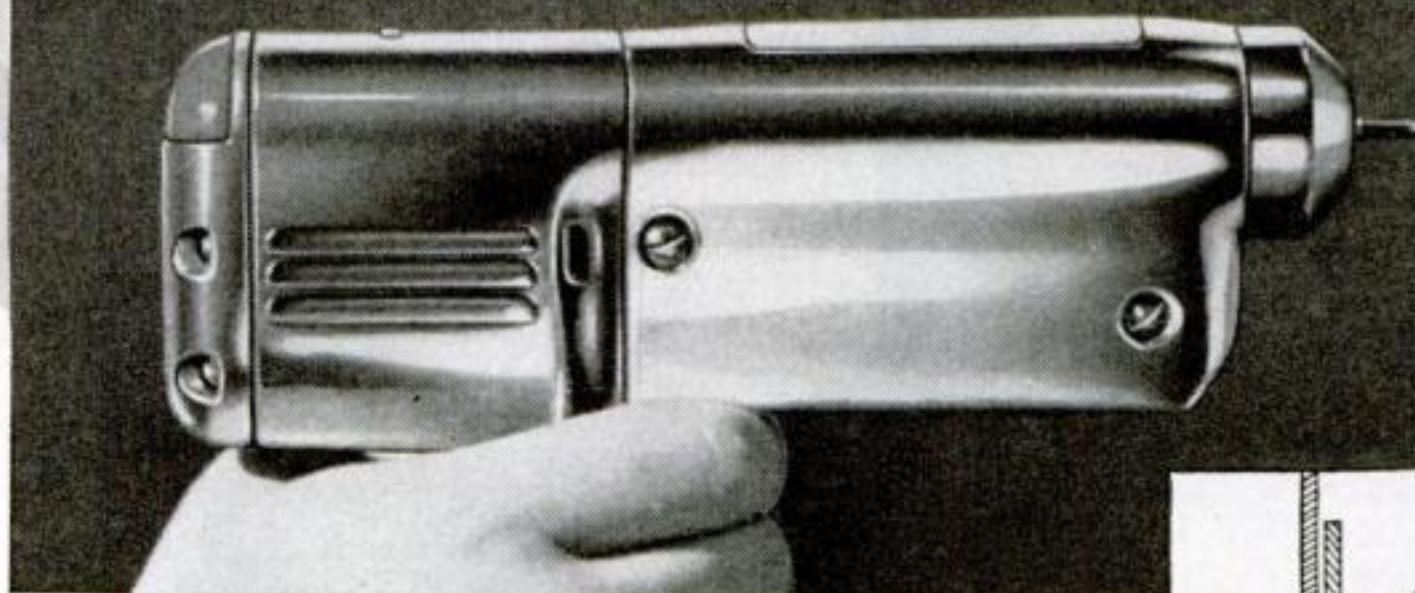
4 Each tack supports one end of each of 6 brass strips. Since there are 60,000 strips, this would call for 10,000 tacks. But as each strip has two ends, twice as many tacks are required. In short, the number of tacks needed is about one third the number of strips.

SAVE PAPER—SAVE A LIFE

Paper is a precious war material, packaging food, ammunition, weapons, and blood plasma. Save all you can to make sure these supplies reach our armed forces in perfect condition.

Ingenious New Technical Methods

Presented in the hope that they will
prove interesting and useful to you.



New Air Tool Drives "blind" Rivnuts Accurately... Automatically

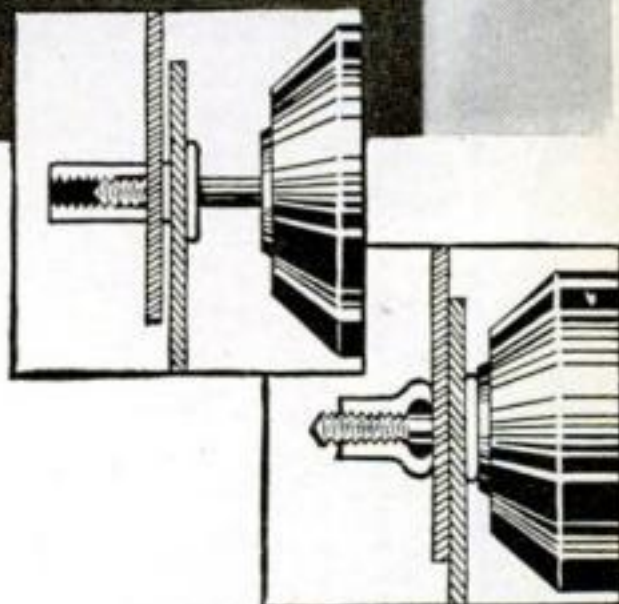
Installing "blind" RIVNUTS quickly with precise, positive upset while working entirely from one side is now possible with the recently developed Auto RIV-Driver. Completely automatic, the tool runs a threaded mandrel into a Rivnut, upsets it, backs the mandrel out and stops the tool. Operators simply press a throttle; make no manual adjustments for any operation. Rivnuts are installed 6 to 8 times faster than formerly; rejects are almost completely eliminated.

The tool can be adjusted to upset at any depth required. Once set, adjustment is tamper-proof—every Rivnut is driven accurately and uniformly. An indicator on the tool handle lights when the upset is correct; does not light if Rivnut is improperly headed.

Powered by compressed air, the Auto RIV-Driver weighs just 4¼ pounds; is 9½ inches long; balanced for efficient handling by women operators.

You all know that our fighting men need the finest quality materials that we here at home can produce. That goes for Wrigley's Spearmint, Doublemint and "Juicy Fruit" chewing gum, too. Our stock pile of raw materials that goes into the making of Quality chewing gum is getting lower and lower. Until we can again build up our raw material inventory, we are sending all of our limited output of Quality chewing gum to our fighting men and women overseas, only.

*You can get complete information from the Independent
Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago 6, Ill.*



Rivnuts (mfd. by B. F. Goodrich Co.) are internally-threaded tubular rivets which can be installed "blind" while working entirely from one side of the job.



Automatic action, positive depth control and visual indicator assure correct and uniform installation of rivnuts with new Auto RIV-Driver.

Y 120

"One of the Freedoms I will feel I have earned will be to have a Harley-Davidson under me again"



No letter, among the thousands we have received, is more typically American than this one from Seabee "Lefty" C —

"When I was a civilian, I had a Harley-Davidson. Its performance was superb. Have shore duty here with the Navy Seabees. Harley-Davidsons are used for specialized duties, and they never balk on the most rugged assignments. One of the freedoms I will feel I have earned will be to have a Harley-Davidson under me again and feel the good old American wind biting my face."

Many thousands of motorcycle fans feel the same way, Lefty. Like you, they are earning their freedoms — the hard way. You're all hastening the return of gypsy tours, race meets, hillclimbs and endurance runs. And we can assure you that when those "freedoms" are yours again, the newer, better Harley-Davidsons will really have what it takes to make the good old American wind bite your face! Put every spare dollar into War Bonds — thrill to your own Harley-Davidson after Victory!

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Write for free copy of
ENTHUSIAST
MAGAZINE,
filled with motorcycle
pictures and stories.



HARLEY-DAVIDSON
MOTORCYCLES

What's Ahead in Electronics?

(Continued from page 73)

down commercial marine and aircraft equipment. This may become a fairly lucrative field for the small or medium-size radio manufacturer who knows design and, producing in moderate quantities at a reasonable cost—say \$150 for a complete private airplane installation—can consolidate his position before the market assumes large proportions and the big companies move in to take it over.

The magnitude of the postwar market for private-aviation radio can be only roughly estimated. In 1941 there were about 25,000 private airplanes in the United States. Representative Clarence F. Lea, chairman of the House Committee on Interstate and Foreign Commerce, predicts a 1,000-percent increase in air traffic by 1950. If private airplanes multiply in the same ratio, we may reckon with about 250,000 of them in 1950. Assuming a straight-line rate of increase, that represents about 50,000 new private airplanes a year between, say, 1945 and 1950.

In 1941, compared with 25,000 airplanes, 29,000,000 automobiles were licensed in the United States. That is what you call a mass market. There are now 60,000,000 broadcast receivers and 31,000,000 "radio families"; that, too, is a mass market. Obviously private aviation offers no such outlet for electronic equipment in the foreseeable future. Just the same, what with the airplanes themselves and some 6,000 airports, many of which will require radio-communication, aviation, and control facilities, it does offer a sizable and important market. Moreover, it is a foregone conclusion that the military and naval forces will operate upwards of 20,000 airplanes after the war, with a high rate of replacement—perhaps 5,000 a year—supplementing private and commercial aviation requirements for electronic equipment.

On the technical side, the tendency in aviation radio is toward the high and very high frequencies in the 75-150 megacycle band. Eventually it will no doubt invade the ultrahigh-frequency region (300-3,000 megacycles). In general, the higher the frequency, the less natural static is encountered. This is one factor in the trend. Another is that short waves afford new channels, and the antennas, being correspondingly small, are just right for installation on aircraft. Again, it is difficult to obtain a sharp radio beam with long waves. Thus aviation radio will expand toward

(Continued on page 216)



THIS AMAZING FLASHLIGHT BATTERY STAYS FRESH FOR YEARS

Power Is There—When You Need It!

Many flashlight batteries go dead just lying around in a flashlight. But not Ray-O-Vac LEAKPROOF Batteries! With LEAKPROOF'S patented sealed-in-steel construction, the power won't leak out—it's there when it's needed for years and years. And it protects your flashlight from corrosion damage.

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NOW GOING 100% TO OUR ARMED FORCES**

FLASHLIGHTS



BATTERIES

BUY WAR BONDS



BUY WAR STAMPS

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OTHER FACTORIES AT CLINTON, MASSACHUSETTS • LANCASTER, OHIO • SIOUX CITY, IOWA

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A remarkable stoker already used by thousands of home owners—fits into any furnace or boiler. Manufactured for over 9 years. So automatic that it takes coal from your present coal bin, going around corners if necessary, feeds it to the furnace, burns it as demanded by a thermostat located in the living quarters of your home, and empties the ash into a sealed container. There is no coal to shovel, or clinker to dig! Made in several sizes . . . If you are planning to build a home in the future, choose the complete Air Conditioner, which has this automatic stoker built in. Send for full information on how you can be sure of an early delivery of a Pocahontas Automatic Stoker after the war.

WRITE TODAY!

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POCAHONTAS
BIN-FEED ASH REMOVAL STOKERS

What's Ahead in Electronics?

(Continued from page 214)

and into the microwave region. In fact, the Civil Aeronautics Administration is already preparing to shift its radio-range transmitters from the present standard frequencies of 200-400 kilocycles to a new standard of 119-126 megacycles, beginning during the next few months.

The older arts of telegraphing and telephoning over wires will continue to assimilate electronic developments after the war. For a long time the telephone engineers, in particular, knew what they wanted—a high-fidelity amplifier, or repeater, for voice currents—but it took the radio engineers, probably the most intrepid group of technological adventurers in history, to give it to them in the form of the vacuum tube. The telephone people adopted Lee De Forest's audion in 1912 and subsequently improved it. This marks a turning point in modern communication. Before that, about all that wire and radio communication engineers had in common was the dot-and-dash code, and they used different versions even of that—American Morse and Continental Morse.

After 30 years of evolution, with 123,000 electronic voice-frequency repeaters installed in the Bell System alone, about the only difference between their respective fields is that the signals in one case are transmitted over wires and in the other through space. And even this difference fades out as the telephone engineers resort to coaxial cables and wave guides, in which radio waves travel through confined space. The effect of electronics in the future will be to break down what remains of the compartments between the branches of communication engineering. The process has already gone so far that what is said below about wire telephony covers most of the prospective developments in space radio as well.

A modern telephone system is inconceivable without electronic oscillators, amplifiers, rectifiers, and controlling devices. To illustrate:

1. In place of unreliable, unsightly, and uneconomical open-wire construction on crossarms, a modern telephone system uses cables incorporating many relatively fine insulated wires in a lead sheath. But cable circuits have higher transmission losses than heavy open-wire circuits, and could not be used for long-distance traffic without electronic amplifiers to make up the huge aggregate losses. Amplifiers not only ex-

(Continued on page 218)

No One Need Pay More than \$40 for a Quality Hearing Aid!

America's Overwhelming Swing to the New Zenith Radionic Hearing Aid Proves It!



SUCCESS speaks for itself! America's hard of hearing—eager to enjoy a fuller life, to take a more active part in working for victory—are buying the Zenith at a rate undreamed of before in the hearing aid industry! Here, indeed, is conclusive evidence that no one need pay more than \$40 for a quality hearing aid!

How can Zenith bring its finest quality thus within reach of all? One reason, of course, is Zenith world leadership in the exclusive manufacture of radionic products. Another is this: The Zenith is built not to a price, but to an improved, modern principle of hearing aid design: INSTANT PERSONAL ADJUSTMENT. You, yourself, "focus" this instrument for your particular hearing needs—for different voices and surroundings—as conveniently as you focus a pair of binoculars!

That's why the Zenith requires no elaborate testing and frequent adjustments by high-paid, high-pressure salesmen . . . no special offices, home calls or other expensive "trimmings." *Zenith Quality Is in the Instrument Itself!*

No longer is there any reason to delay hearing a demonstration. You owe it to yourself—to your country—to all who have your interest at heart. Your local Zenith-franchised optical establishment invites you. No one will urge you to buy, or call at your home. For free descriptive booklet, sent in plain envelope, write Zenith Radio Corporation, Dept. PS6, P. O. Box 6940A, Chicago 1, Illinois.

\$40

COMPLETE, READY TO WEAR
Available at Zenith-Franchised Optical Establishments Throughout America

Only Zenith Gives You These Great Advantages.



1 New "Self-Focus" Hearing Control

The flick of your finger brings hearing into range for your particular needs—for different voices and surroundings—as conveniently as you focus binoculars! Outmodes old-way "fixed-adjustment" principle.



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An exclusive circuit—especially developed by Zenith engineers to insure outstanding performance throughout the life of the batteries. Brings average operating cost to only 3/10 of one cent per hour.



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You get the fine precision that modern knowledge and engineering made possible, at about 1/4 the price of other quality vacuum tube instruments! One model—no "decoys." One quality, one price.



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Guaranteed by Zenith . . . world's leading manufacturer of radionic products exclusively, for a full year. You also get unique Zenith 5-year Service Policy with coverage enjoyed exclusively by Zenith wearers.

ZENITH RADIO CORPORATION, CHICAGO 39, ILLINOIS

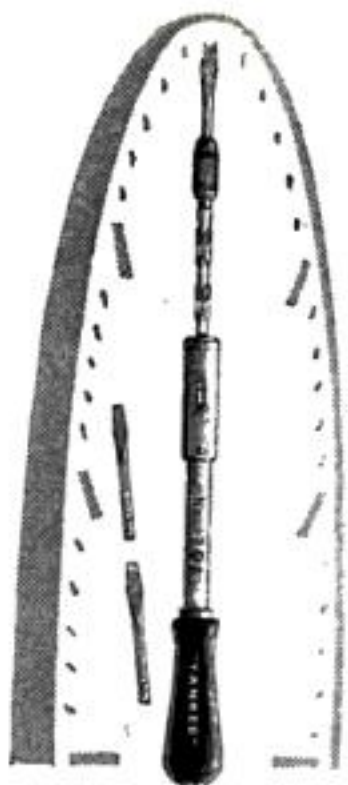
*Accepted by American Medical Association
Council on Physical Therapy*

There are cases in which deficient hearing is caused by a progressive disease and any hearing aid may do harm by giving a false sense of security. Therefore, we recommend that you consult your otologist or ear doctor to make sure that your hearing deficiency is the type that can be benefited by the use of a hearing aid.

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All Production Now for War or Rehabilitation

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MAKE TIME with "YANKEE" TOOLS!

Do the tools you buy make your work easier, faster, more efficient? Do they save you time, money, trouble? Will they stand the pressure of hard work, earning their keep by long, dependable service? They will, indeed, if they are "Yankee" Fine Mechanics'

Tools, the choice of true craftsmen everywhere, for more than half a century. There's only one trouble with "Yankee" Tools today, but that's a trouble that will be corrected quickly by Victory: Supply can't keep up with demand . . . for "Yankee" Tools, you see, are at work for war. So remember the built-in ingenuity of "Yankee" Screw Drivers, Drills, Vises, Bit-Braces, and Tap Wrenches. They've been *designed* to make time! And making time, above, is "Yankee" Spiral Screw Driver No. 130A—a size for every purpose.


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Established 1880

Makers, also, of "Yankee-Handyman" Tools



FLASHLIGHTS and BATTERIES

NOW SERVING OUR MEN ON
EVERY FRONT . . . MAY SOON BE
BACK TO SERVE AT HOME AGAIN!



BRIGHT STAR BATTERY CO., CLIFTON, NEW JERSEY

What's Ahead in Electronics?

(Continued from page 216)

tend the range of wire telephony indefinitely, but also save enormous quantities of copper. In time, cables will completely replace open wires on all long and important circuits.

2. For economical utilization of equipment, long lines must be multiplexed; that is, each pair of wires must serve for several communication channels simultaneously. This is done by using carrier currents of various frequencies, each modulated with a telephone conversation, telegraph code, television image, or other intelligence. Electronic oscillators generate the carrier currents, electronic modulators impress the signals on the respective carriers, electronic rectifiers separate the signals from the carriers at the receiving end. The growth of carrier-circuit mileage, already very rapid, will increase further after the war if economic activity is maintained at a prosperous level.

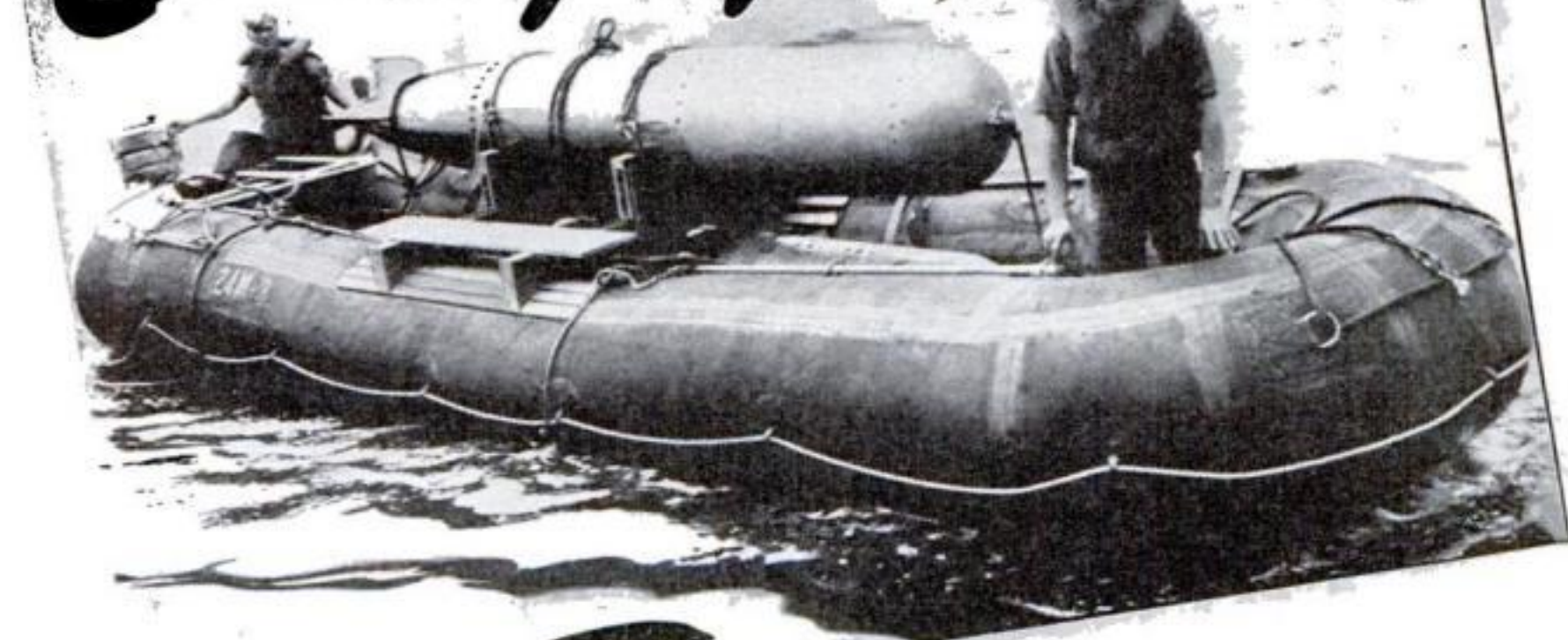
3. The amplifiers, or repeaters, which control energy levels on the lines must themselves be controlled. If the level is too high, interference, or crosstalk, between circuits results. If it is too low, the signal drops below the noise level. Overall attenuation varies greatly with temperature. Amplification must be constantly adjusted to match the varying attenuation. This is done automatically and with the utmost precision by means of electronic devices analogous to the automatic volume control on a radio receiver. Developments in this field will parallel the increasing reliance on automatic control in the manufacturing industries.

On all types of circuits, the amount of intelligence which can be carried depends on the width of the frequency band. Consequently, the trend in both wire and radio communication is toward wider and wider bands. An audio-broadcast channel may be five kilocycles wide; the corresponding channel for television, or video broadcasting, by prewar standards, may be 1,200 times as wide—6 megacycles—and by all indications it will have to be still wider for postwar television. This calls for amplifiers which will pass extremely wide frequency bands. It also calls for higher-frequency carriers. Consequently wire transmission, like radio, is moving into the ultrahigh-frequency region.

When frequencies get up into hundreds and thousands of megacycles, special conductors, such as coaxial cables and hollow

(Continued on page 221)

Coming Up!



...Two TIN FISH FOR TOJO!

UNTIL it is slammed straight for the belly of a frantically twisting, dodging Jap ship, a Navy aerial torpedo should be handled with care! And that is the way this deadly pair, cradled one over the other in a rubber barge, are being transported. In rearmament service these big rubber boats provide their lethal loads with a "safety zone" . . . a plump cushion of air that completely surrounds the cargo, safeguarding it against the danger of shock or collision. Many Evinrudes are used in such service, providing capable driving power and a high degree of maneuverability.



1 Servicing seaplanes is another job for which rubber boats are ideally adapted. For powering big rubber boats, Evinrude now produces a special model of its famed Lightfour, built with deep shaft, high-ratio reduction gear, and 360 degree steering that permits the boat to be maneuvered in any direction.



2 Up she comes, the day's work done! This photo shows the type of bracket widely used for mounting an Evinrude on a large rubber boat. Evinrude has developed many special mounting brackets to meet the varied needs of the scores of different types of small craft used by the Army, Navy and Marine Corps.

3 The Japs use outboards too, as is shown by this photo of a Jap outboard captured somewhere in New Guinea, and patched up by our boys to serve in ferrying supplies to the beach. Perhaps, by this time, it has been replaced by a sparkling Evinrude Speeditwin, a "popular number" in the far Pacific!



FREE! Send for copy of 1944 "Owners' Edition" of the Evinrude News. A pictorial magazine that covers outboards in war and peace — profusely illustrated with photos showing Evinrudes serving the Army and Navy, and pictures of happy peacetime uses to follow! Write for your copy! EVINRUDE MOTORS, 5055 N. 27th St., Milwaukee 9, Wisconsin.



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What's Ahead in Electronics?

(Continued from page 218)

tubes (wave guides) must be devised for point-to-point transmission. The first cost of such facilities naturally is high, but their carrying capacity is so great—hundreds of channels can be obtained with one of them as compared with perhaps a dozen on a cable-carrier pair—that their postwar commercial development is certain. This development, in turn, will require new types of vacuum tubes and associated equipment to generate, amplify, and control the extremely high frequencies involved. Such facilities are now in the research, precommercial, or limited-commercial stage. The postwar period will witness their application on a large scale, extending the range and efficiency of the services they perform.

Electron tubes also are widely used on carrier telegraph systems, and in the wire-telegraph plant generally. One of the principal lines of electronic development by telegraph, telephone, and radio companies is in facsimile and picture transmission, in which photographic or other material is scanned by a photo cell and the resulting signals are transmitted by wire or radio to be reconverted into light impulses and recorded at the other end. The principles of facsimile transmission were established before very much was known about electrons. Electronics changed it from a scientific toy to an important commercial device. After the war, telegrams, as well as maps, drawings, blueprints, advertising copy, and the like, will often be transmitted electronically in facsimile form. In picture transmission, if we compare present-day newspaper halftones with those of 10 years ago, we can appreciate the progress that is being made.

This completes our survey of the postwar role of electronics in communications. Without electronics present-day communication systems would revert to the status of the early 1900's. With electronics they will match, in perhaps 10 years, the prodigious advances of the past 40 years. But if this is true of point-to-point communication, which after all did exist before electronics came to the fore, it must be even more true in relation to audio broadcasting and television, which are direct creations of electronic technique.

The postwar development of the mass communication services will be discussed in an article on *ELECTRONICS AND ENTERTAINMENT*, to appear in our next issue.

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The Havoc Does It

(Continued from page 80)

shelved, and even the single-place ships were carrying bombs, strafing targets, and doing other types of work. The British had proved that the Havoc could be used for medium and low-altitude bombing, dive bombing, general support tactics for ground units, antitank operation, reconnaissance, photography, torpedo carrying, mine laying, and a bit of every other job imaginable. Some of the prize testimonials of the A-20's glory as a battle steed came from a group of pilots recently returned from action against the Nazis. These men were resting from the effects of more than 50 missions apiece over Europe at an AAF redistribution center while awaiting reassignment to action. One of them was Lt. Bernard Bell, who touched off the American bombing of *Festung Europa* in an A-20 in June 1942, when he dropped his eggs on the rail marshaling yard at Hazebrouck, France. Another was Pilot Officer Levi L. Nicholson, of the Colorado State Agricultural College, a veteran of the Mediterranean theater who swore by the stamina, speed, and fightability of the Havoc when he said, "All I want from briefing are the altitude and the target. We'll get home if anyone can."

Nicholson worked with an all-A-20 outfit, which helped to chase Rommel out of Africa, smashed Sicily, and then moved up the Italian boot, blasting the retreating Nazis and covering the advance of Americans, British, and Canadians. The other members of the group were Lt. Homer E. Gentry, who joined up from John Tarleton Agricultural College, Texas, and Lt. Donald L. Brock, of the University of Nebraska. Both these officers were bombardiers.

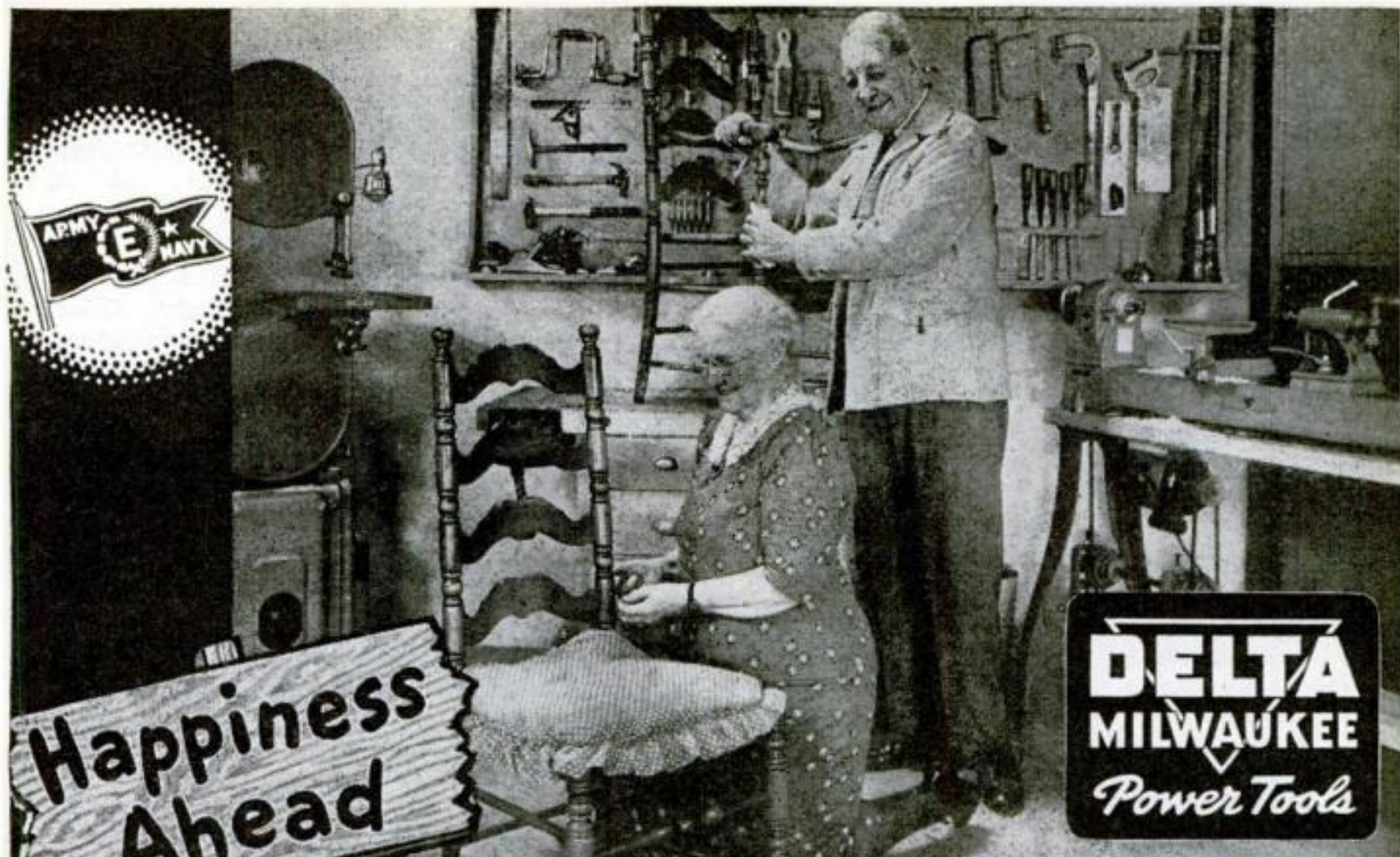
Nicholson, Gentry, and Brock, like most of the others who meet the Nazis in combat, respect the foe's ability to fight, both in the air and from the ground.

"In A-20's, though," Brock stated assuredly, "we worked out tactical means for hitting targets and getting out fast. We chased across the country like cottontails in a briar patch. Ten seconds was our limit for a bomb run, and, Mister, if you think that's a lot of seconds to get on a target and cut 'em loose, try it sometime."

"Don't think those '88' anti-aircraft gunners fool, either," Gentry added. "They can cut fuses to burst at 200 feet up."

In the beginning, as the early African push started, A-20's swept across the desert at bush-top level, strafing convoys, knocking out trucks with machine-gun fire, and

(Continued on page 224)



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The Havoc Does It

(Continued from page 222)

bombing the daylights out of tanks. One six-plane flight left a five-mile line of burning vehicles when it hit a column in the hills.

Those boys swept in so low they were forced to pull up to clear the tanks. Over open terrain, ground fire proved murderous, and shortly the A-20's largely abandoned their strafing tactics, leaving that unpleasant chore to the fighters, and moved up to altitudes of 7,000 to 10,000 feet. Up there, covered by Spitfires and Lightnings, they escaped some of the more accurate small-arms fire.

Nicholson, Gentry, and Brock flew ground support. That's the A-20's primary job—scattering fragmentation high explosives and bombs across airfields, troop concentrations, gun emplacements, and railroad yards. Along with others of the group, they soon evolved special tactics for hitting their objectives. Using a combination of vertical and horizontal evasion and a quick 90-degree turn, they often would hit and be gone before artillerymen could calculate their positions and get shells into the air.

Crews depend upon speed and deception, for A-20's operate from airfields smack behind the front lines. From briefing to attack to landing, many missions are completed within 20 minutes.

Typical of the method was an attack on positions near Souk-el Arba, Tunisia. Twelve planes in two boxes of six soared to 9,000 feet. Then, climbing, diving, and weaving to throw the gunners off, the flight scudded through mild flak until over a point three miles abeam of their target. At that point, the lead bombardier ordered his pilot into a left turn, and bomb doors on all planes began to swing down. Bombardiers crouched over their sights, counting one . . . two . . . three—up to seven. Bombs away! Only seven seconds to get on the target. How the egg tossers on the big Forts and Libs would like to trade their two and three-minute runs for such a short approach!

Wait. Only the first box went through. Brock, leading the second six, perceived in the near distance a group of nine large JU-52 transports parked immediately off the airport runway in an olive grove. Quickly he swung his box off the run and headed for the grove. Just eight seconds later, 40 100-pounders cascaded into that grove, smashing eight of the transports, one later reported to be the personal plane of Gener-

(Continued on page 226)



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The Havoc Does It

(Continued from page 224)

al Von Arnim, now an Allied prisoner. "Good job," was the commanding officer's comment when the flight landed.

Only one plane in each box carries a bombardier. He directs his pilot where, and sometimes how, to fly. Before each take-off, following briefing, the bombardiers check their English Mark IV sights for the planes' terminal velocity, ground speed, altitude, wind direction, and wind velocity. With these variables set, they need only orient the sight with the plane's heading on the bomb run, keeping a red arrow matched with a red spot on the compass. If they press the bomb release at the correct instant, the target is certain to be engulfed by explosions.

When our troops begin to move forward, the A-20's switch to ground support, concentrating on the enemy's forward areas, loosing clusters of bombs on troops and emplacements. For this purpose a bombing line is established along a line our ground forces may reach in two hours. Give the enemy hell, but protect our boys!

Pilots, gunners, and bombardiers take great pride in their attack bombers. And why not? Scores of A-20's have completed 300 and more hours of combat without overhaul. As for strength and maneuverability, listen to Gentry:

"We moved up to Foggia from Taranto, following the Eighth Army up the boot of Italy. Told we would have a landing field, we were surprised when we landed on the side of a hill, our runway marked by four white barrels set at the corners. In taking off, we jumped a fence at 110 per. After bombing up, we took off for a target that would be only 20 minutes away in good weather. Flying through and around lousy clouds and squalls, we dumped our stuff on troops there 40 minutes after leaving Foggia. The weather closed in, and we thought we were lost. A couple of minutes later the lead pilot found a hole, and in boxes of six all 48 planes peeled off, reversed, and dived 7,000 feet. We came out at 2,000, under the clouds and beat it to Foggia. We had to jump a ditch on the near edge of the field, but that's duck soup for an A-20."

This is only part of the A-20 story. In Russia, over 2,000 A-20's were delivered to the front. The Reds modified the ships, increasing their firepower. German reports, reaching the U. S. from neutral sources, state that the A-20 has had its nose packed

(Continued on page 228)

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The Havoc Does It

(Continued from page 226)

with four of the 23-mm. fast-firing cannon which rode the Stormovik to immortality. The red-starred Havocs have been turned over to Cossack squadrons which are said to mock at comrades who fly higher than the tree tops. "Comrade Ivanovich is trying for the squadron altitude record," they wisecrack when a flyer soars above 100 feet. The first of the new Panther tanks captured from the Germans was reported to have been a victim of an A-20.

An interesting point of Havoc construction is that the rear gunner can hold the ship level with an auxiliary control should the pilot be hit or forced to abandon ship. For this reason, it is the only plane in which the captain is not the last to bail out, the rear gunner hitting the silk when the others are safely over the side.

In the Southwest Pacific, the commanding general wanted a long-range day-and-night fighter that wouldn't have to worry how maneuverable a Zero was but could just sit out of range and blow it to pieces. Out popped the P-70—a basic Havoc airframe with a blocked-in nose. This proboscis packed either six .50 caliber machine guns, or four 20-mm. cannon. The fire from these guns was supported by a top turret carrying two .50 caliber guns, as in a heavy bomber, and a single gun in the belly. In the early days of the island warfare these craft swept the islands at night, working in close contact with the ranging equipment and searchlights, and keeping the night raiders away from the weakly held installations. A-20's rigged as fighters and bombers crossed the Owen Stanley Mountains of New Guinea to cripple the Jap air strength while it was still on the ground—a historic flight that revealed the possibility of such a crossing.

Currently, there are 11 modifications of the basic DB7 design in action. Their jobs are almost endless in their variety. There is talk that a newer and more powerful craft may take over from the old Havoc. This is probably true. It should be remembered that the Beaufighter, Mosquito, and certain functional modifications of the B-25 and B-26, were made on the basis of what was learned from the Havoc's operations. The Germans probably modified their JU-88 to serve a similar purpose, the trend back to multipurpose craft having started with the Havoc's success. What trails behind is simply a shadow cast by the wisdom of the men who saw the need and built the lead plane, that versatile virtuoso of combat—the Havoc.

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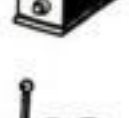


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Our Planes Can Take It

(Continued from page 121)

wheel of a ship with a tricycle landing gear serves admirably as a baffle for gunfire from below the plane's nose.

Carrying the idea a step further, the designers have fitted craft with aluminum-alloy deflector plates to protect the cockpit or other vital parts. On a fighter these might be installed along the top and bottom of the engine cowlings, to deflect bullets aimed at either the pilot or engine from a point ahead of the plane. In a bomber or a multiengine fighter, deflector plates might be arranged at the front or sides of the pilot's cabin, around the outer sides of the engine cowlings, on the floor at the stations of the aft and waist gunners, and so on. Lighter armor plating may be used when it is "fronted" by these deflectors.

There is still another trick to saving weight through clever location, although this is highly dependent upon the structure of the plane. The plating is placed as close to the pilot as possible, so that he can hide behind it more effectively. The area of armor required varies directly as the square of its distance from the object to be protected. A piece of armor two feet square might give a pilot adequate protection if set two feet in front of him; but, if the structure did not permit installation closer than four feet, a piece four feet square would be required to give the same degree of safety.

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The latter consists of a solid piece of alloy steel, of uniform hardness throughout. Face-hardened plate is not of even consistency, the front or face of the plate being of greater hardness. Both types contain approximately the same amount of resistance, or "ballistic limit," up to thicknesses of three eighths of an inch. Plates of the same area and thickness weigh about the same. In thicker platings, the face-hardened armor is lighter in proportion to its ballistic limit. This type of armor does not have a tendency to shatter under heavy fire. It does not "spall" easily. Spalling occurs when small, round pieces about the

(Continued on page 232)

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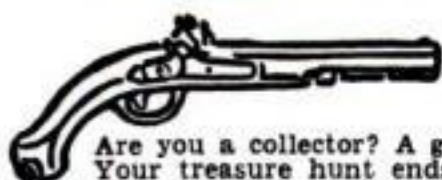
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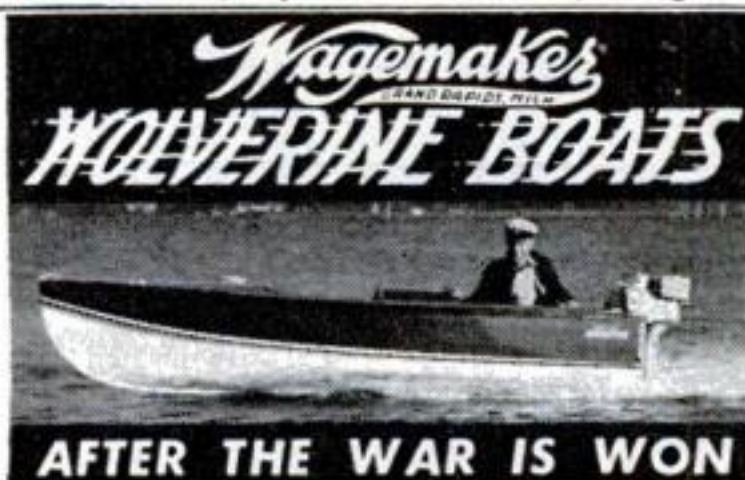
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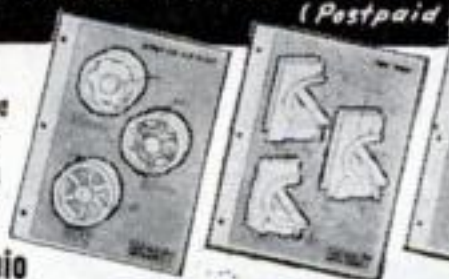
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Our Planes Can Take It

(Continued from page 230)

size and thickness of a dime fall off the front or rear of the plate at the point where the bullet hits the face. These advantages are offset by production difficulties.

Homogeneous armor plate has a tendency toward shattering and spalling, because of the uniformity of the plate and because the impact sets up vibration within the plate's molecules, but this type is easier to adapt to mass-production methods, costs less, and requires a simpler heat treatment. Both types may be used in the same plane, the homogeneous type usually being employed in places where maintenance men can get at it handily for removal or repair.

The mounting of armor plating involves a trick or two in itself. There has been a tendency, in a couple of the newer American craft, to incorporate armor in the fuselage structure, as part of, or in place of, a bulkhead, where it could materially strengthen the structure as well as furnish protection. Armor must be accessible for removal and replacement; to facilitate this, it is bolted to the airframe, holes being drilled along the edges of the plate to accommodate the special steel bolts. Flexible mountings, such as the rubber bushings used on engine mounts to absorb vibration, have not proved successful. It has been found that rubber mounts sustain the vibration and cause prolonged vibrations known as "racking." Glancing bullets cause greater racking—through more uneven frequencies—than those hitting at normal angles, and this is sometimes sufficiently strong to tear the armor plating from its mount. The vibrations must be damped out quickly.

We are making great progress in the manufacture of transparent armor (P.S.M., Feb. '44, p. 74). This is used for windscreen panels, front sections of gun turrets, and in other places where visibility and protection are essential at the same time. The weight problem, however, is more of a headache here than in steel armor plating; the laminated glass must be quite thick because of its low ballistic limit. Clever location is again used to good advantage. The panels of transparent armor are set at angles and as close to the eyes of the pilot or gunner as possible. The hard surface of glass is a good deflector, but it does not resist bullets at right angles in the same manner as does steel plate.

Glass stops the bullet by partly breaking it and absorbing these pieces between the layers of the glass. The transparent armor

(Continued on page 234)

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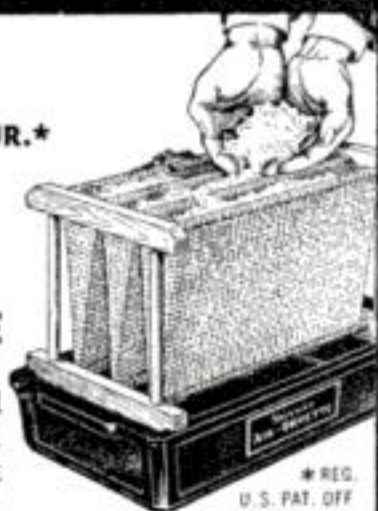
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Our Planes Can Take It

(Continued from page 232)

powders at the point of impact and "stars" and cracks about three inches around it, and pieces of the shattered bullet are retained. These panels of armor are made by taking several sections of highly polished plate glass and bonding them together with a transparent plastic material under terrific heat and pressure into a sort of hot sandwich. But here is the weighty problem: a foot-square piece one inch thick weighs 13 pounds; it takes a section 1½ inches thick to stop penetration of a .30 caliber bullet at an angle greater than 45 degrees at 50 yards and a plate three inches thick to resist a .50 caliber missile. Half an inch of either face-hardened or homogeneous armor plate will accomplish the same trick. This is why the transparent armor is used so sparingly on our fighters and bombers.

Plywood and plastics are being used increasingly in the form of baffles, deflector plates, and "spatter shields." The latter came into use after it was found that bullets glancing off the armor plating were still, in many cases, traveling fast enough to ricochet inside the plane and hit personnel, or damage fuel or hydraulic lines, control cables, or electrical wiring. These shields are usually aluminum angles extending around the edges of the plate's face and lined with plastic or plywood that absorbs the distorted or broken bullets as they glance from the plate.

The AAF Armament Laboratory at Wright Field, Dayton, Ohio, and the Naval Aircraft Factory at Philadelphia are busy with experiments on what is called "composite armor." What's going on is none of Adolf's business and not even speculation is permitted. Another interesting wrinkle, which is less secret, is the use of light steel body armor. Helmets, chest and back shields, and "flak skirts" have been worn by bomber crews (P.S.M., Mar. '44, p. 54). Each piece is held by straps and is quickly removable. Meanwhile, the Office of the Surgeon General and the Ordnance Department are hard at work on the improvement of these types of personal armor, and it may not be long before bomber and fighter pilots, paratroopers, and airborne infantry will fight in regalia reminiscent of warriors of knighthood days.

The photographs appearing at top and center of page 121 are published through the courtesy of The Breeze Corporation, manufacturers of aircraft armor.

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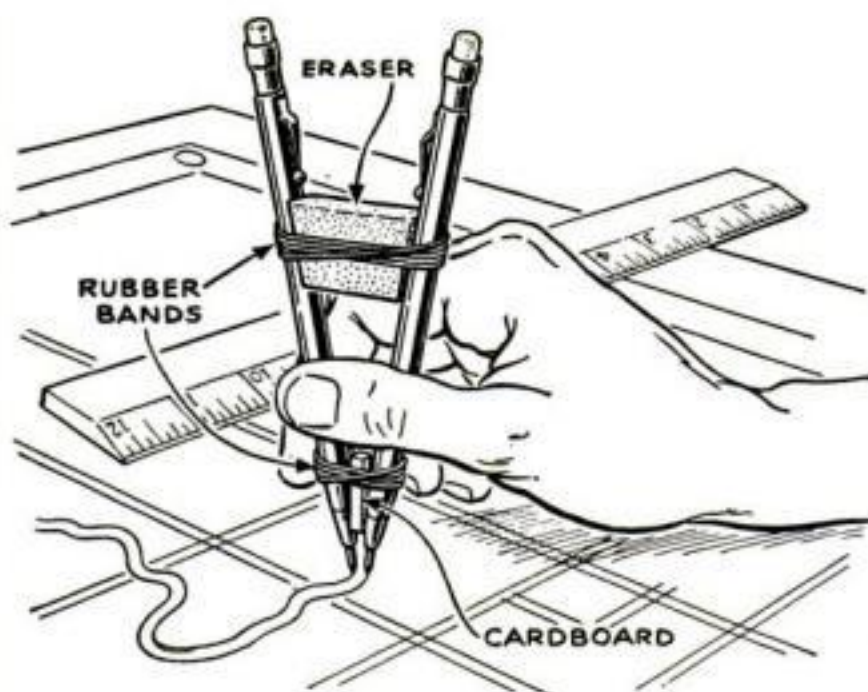


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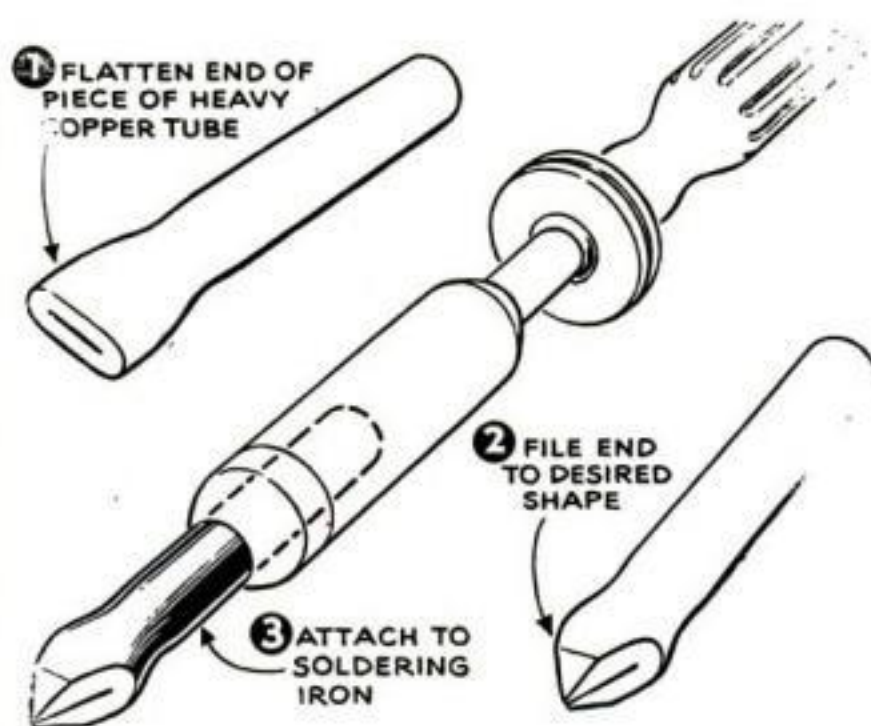
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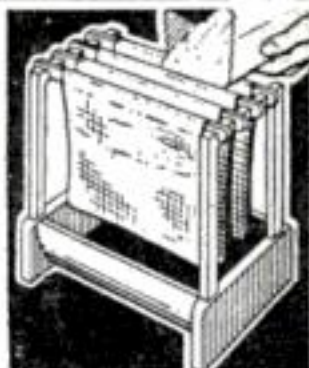
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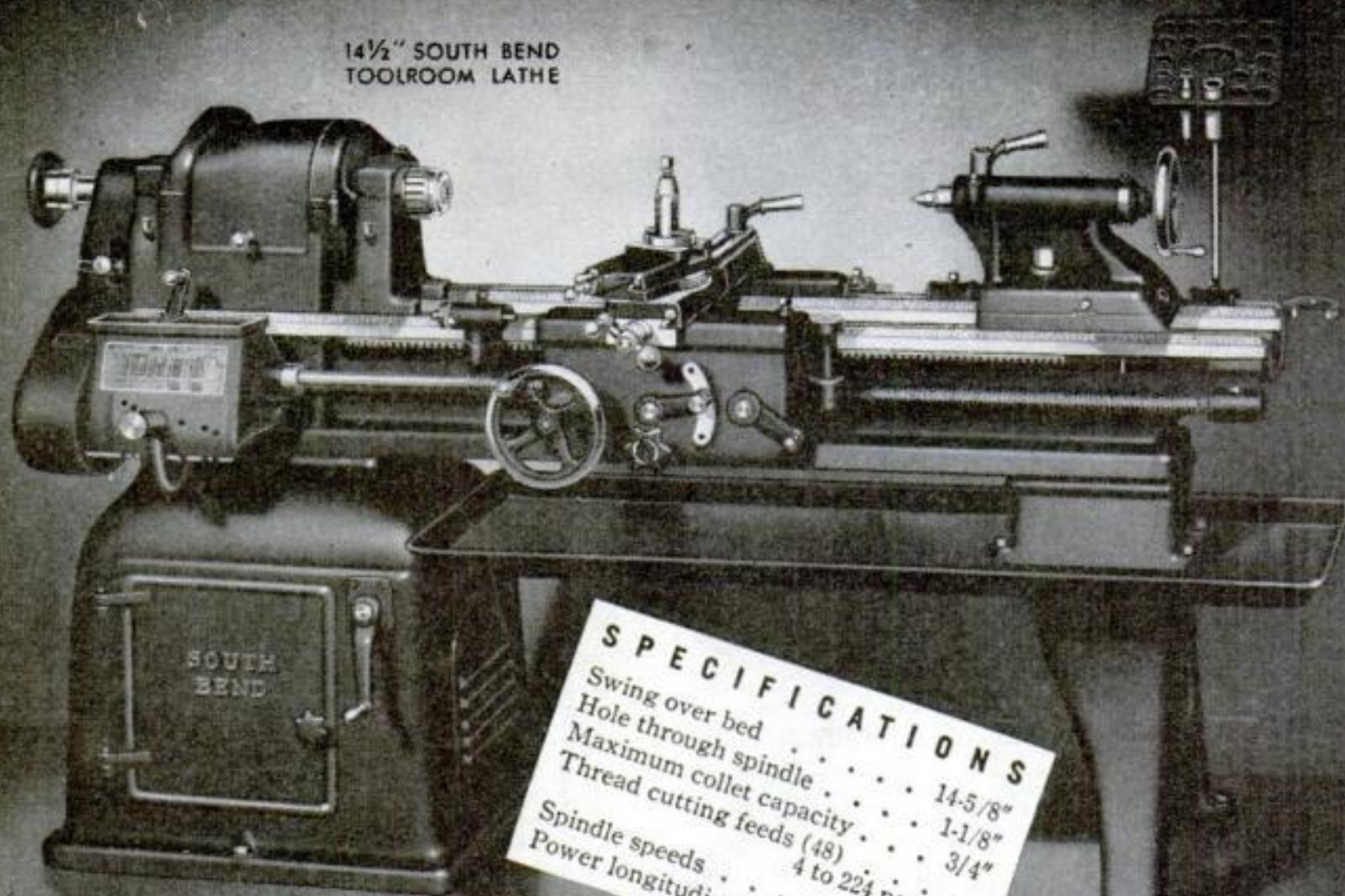
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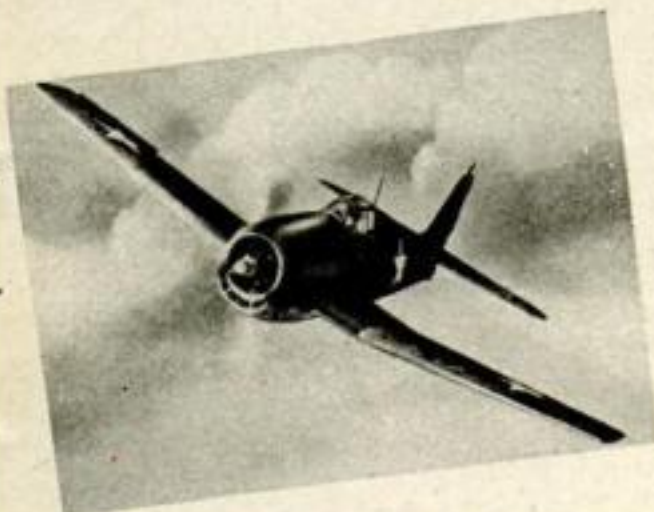
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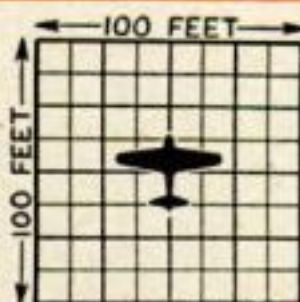
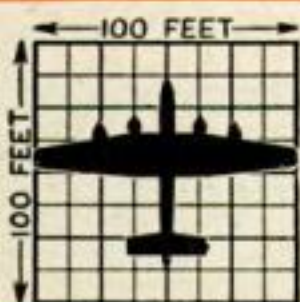
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